SATURN S-I STAGE
FINAL STATIC TEST REPORT

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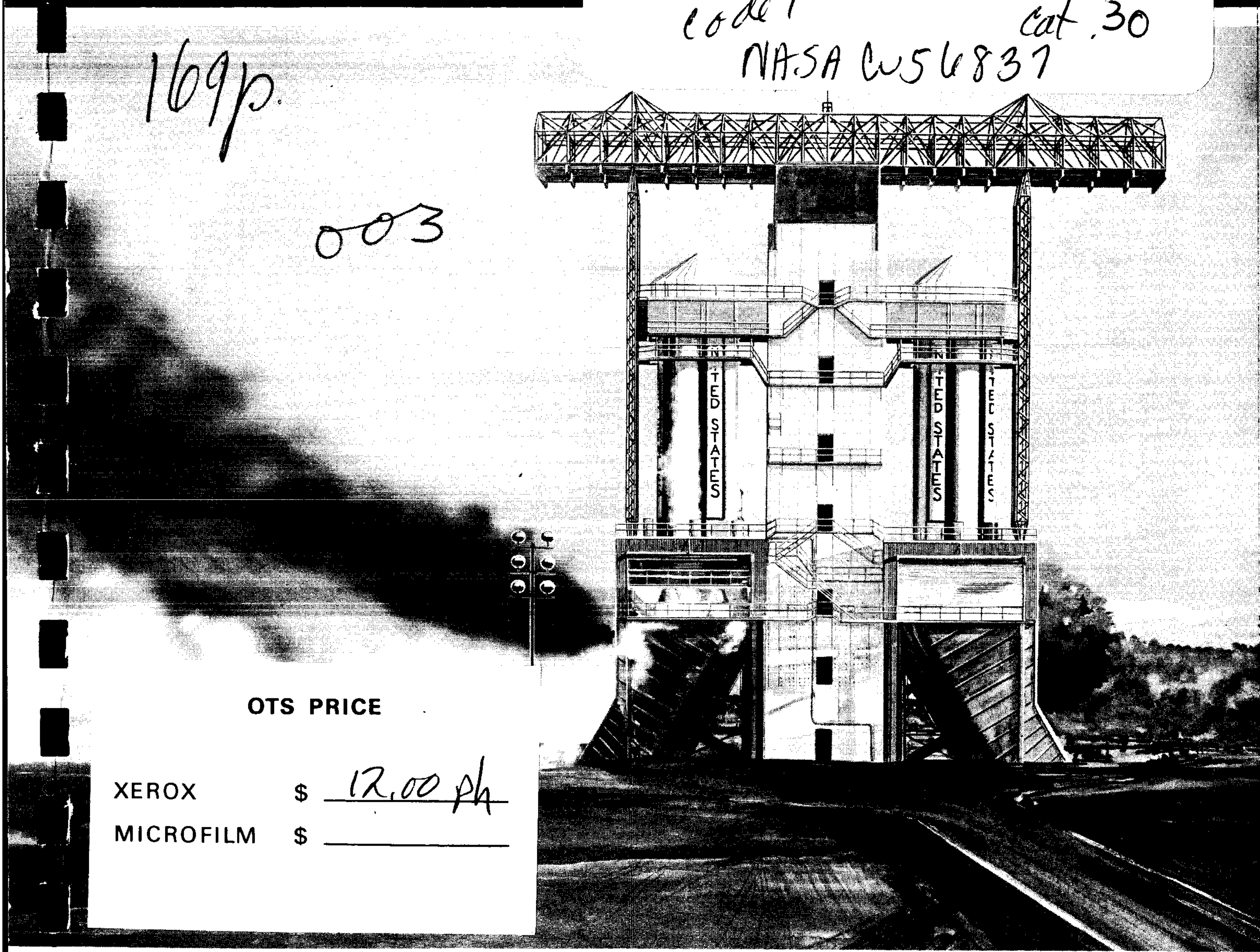

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STAGE S-I-9

SPACE DIVISION CHRYSLER CORPORATION

SATURN STAGE S-I-9

FINAL STATIC TEST REPORT

by

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JUNE 4, 1964

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ABSTRACT

This report describes the acceptance test firings of the Saturn flight stage S-I-9 conducted at the Static Test Tower East, Marshall Space Flight Center (MSFC), Huntsville, Alabama.

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FOREWORD

This report, prepared by Chrysler Corporation Space Division, System Static Test Branch presents the results of the acceptance test firings of stage S-I-9. The acceptance firings of the Saturn S-I and S-IB stages are performed by Chrysler Corporation Space Division for the National Aeronautics and Space Administration at the George C. Marshall Space Flight Center under Contract NAS8-4016, Item No. 1, Static Test Operations.

SUMMARY

This report describes the acceptance test firings of the Saturn flight stage S-I-9 conducted at the Static Test Tower East, Marshall Space Flight Center, Huntsville, Alabama, during the period February 17, 1964, to April 8, 1964.

Static test firings SA-18 and SA-19 were successfully conducted on March 13 and March 24, 1964, respectively. Test SA-18 duration was 35.22 seconds from ignition command signal to inboard engine cutoff signal with the cutoff signal being initiated, as scheduled, by the firing panel operator. Test SA-19 duration was 142.21 seconds from ignition command signal to inboard engine cutoff signal, with LOX depletion cutoff of the outboard engines being initiated 3.77 seconds later when the Thrust OK pressure switch on engine 4 dropped out.

Engine operation during test SA-18 was satisfactory. All engines produced thrust values within the specified limits of 188K$\pm$3 percent except engine 3 (S/N H-5025) which was out of limits on the low side; however, the thrust values attained by engines 1, 4, 5, 6, 7, and 8 were on the low side of the specified limits. All engines except engine 2 (S/N H-5012) were reorificed (GG LOX orifice only) prior to test SA-19.

Engine performance was satisfactory during test SA-19. All engines produced thrust values within the specified limits.

The LOX pressurization system functioned satisfactorily during tests SA-18 and SA-19, although the LOX tank pressure exceeded the specified limits of 50$\pm$2.5 psia. During test SA-18, the LOX tank pressure attained a maximum of 54 psia at X+25 seconds. Following ignition on test SA-19, LOX tank pressure fluctuated slightly and stabilized at 54 psia at X+5 seconds. This pressure was maintained until X+33 seconds after which time it slowly decreased to 49.7 psia at outboard engine cutoff. LOX tank pressure was within the specified limits from approximately X+52 seconds until the conclusion of the test.

All acceptance firing test requirements, as specified in the Static Test Plan for stage S-I-9, were successfully achieved. The performance of all booster systems was satisfactory and acceptable for flight.

Stage S-I-9 was removed from Static Test Tower East on April 8, 1964, and transported to the Manufacturing Engineering Laboratory where necessary repairs and modifications to the stage will be accomplished.

SECTION I. INTRODUCTION

The short and full duration firings, tests SA-18 and SA-19, on Saturn stage S-I-9, were performed by Chrysler Corporation Systems Static Test Branch, on March 13 and March 24, 1964, respectively, at the Static Test Tower East, Marshall Space Flight Center, Huntsville, Alabama. The stage had been previously installed in STTE on February 17, 1964, and was subsequently removed on April 8, 1964.

The primary objective of the static firing tests is to demonstrate the correct functional performance and operation of the airborne systems. To meet this requirement, the short duration test and the full duration acceptance test were performed with flight conditions simulated as closely as possible. The short duration firing constitutes a confidence test to verify airborne/ground control system compatibility, checkout instrumentation, and to obtain engine thrust level data. The test objectives are further delineated as follows:

Short Duration Firing

1. Verification of airborne/ground control systems compatibility.
2. Determine propellant tank draining rates.
3. Check of engine calibration with Rocketdyne-delivered GG LOX orifices installed.
4. Check performance of gimbal control system.
5. Reliability and performance of telemetry equipment.

Full Duration Firing

1. Verification of airborne/ground control systems compatibility.
2. Determine propellant tank draining rates.
3. Check performance of gimbal control system.
4. Reliability and performance of telemetry equipment.
5. Full duration firing with flight sequence cutoff utilizing LOX low cutoff sensors.

The static test configuration of stage S-I-9 is defined by drawing 10M10016, Revision A. Stage S-I-9 is the first Saturn S-I stage to utilize the 50 psia LOX tanks pressurization system. Deletions from the flight configuration include the following: stabilizer fins, stage interface fairing, adapter portions of the hydrogen childown ducts, forward compartment cover plates and instrumentation canister doors, LOX replenishing valve, and the LOX-SOX dispersal rings. Hardware additions include upper stage deluge firex ring, inboard turbine exhaust duct extensions, auxiliary LOX dome purge manifold, and three LOX and three fuel fill and drain valves. Flight-type static test heat shield panels and engine flame curtains were used in place of the actual flight hardware. A peripheral tail skirt radiation shield is also incorporated with the static test configuration.

All engine turbopump diverter lips were removed prior to arrival of the engines at MSFC with the exception of engine 2 (S/N H-5012). The diverter lip on engine 2 turbopump was removed after arrival at MSFC and the engine reorificed (GG LOX orifice only). The remaining seven engines were not reorificed at this time since it was anticipated that the engines would require reorificing after the short duration test because of the previously experienced thrust bias between Rocketdyne acceptance test firings and the Saturn stage acceptance firings. All the engines were reorificed (GG LOX orifice only) after test SA-18, with the exception of engine 2. Engine performance was satisfactory for test SA-19.

The performance of each system is discussed in sections 2 through 8 of this report. Sections 9 and 10 constitute summaries of conclusions and recommendations. Included in the appendices are the following: Systems Static Test Procedures; Reports and Memorandums Published Concerning the Static Testing of Stage S-I-9; Redline Values for Stage S-I-9; Saturn Acceptance Test Measuring Program; Test Data Sheet, Tests SA-18 and SA-19; Meteorological Data, Test SA-19; Critical Components Time/Cycle History of Stage S-I-9 While at Test Laboratory; and Unsatisfactory Condition Reports List. These items are listed as APPENDICES A through H, respectively.

Upon successful completion of the acceptance test firings, the Saturn stage S-I-9 was removed from STTE and returned to the Manufacturing Engineering Laboratory for post-test modifications, repairs, and prelaunch hardware installation.

SECTION 2
ENGINE SYSTEMS

The dates and durations (ignition command signal to inboard engine cutoff signal) of the static firing tests of stage S-I-9 are listed as follows:

STATIC TEST	TEST DATE	DURATION
SA-18	March 13, 1964	35.33 sec.
SA-19	March 24, 1964	142.21 sec.

Test SA-18 had a 4/4 engine cutoff sequence, with a 120 millisecond delay between inboard and outboard engine cutoff signal. Cutoff for test SA-18 was initiated by the firing panel operator. Inboard engine cutoff signal for test SA-19 was initiated by the flight sequencer 2 seconds after closure of the LOX low level sensor in tank 0-4; outboard engine cutoff signal was initiated 3.77 seconds later by the Thrust OK pressure switch on engine 4. Thrust decay of engine 4, resulting from LOX depletion, began 122 milliseconds before dropout of the Thrust OK pressure switch.

The following table gives the sea level thrust and turbopump speeds, at a slice time of X+29 to 32 seconds, for tests SA-18 and SA-19. The sea level values were obtained by utilizing the sea level reduction program CU0004 furnished by R-P&VE-PP.

SERIAL NO.	ENGINE	SEA LEVEL THRUST (KIPS) SA-18	SEA LEVEL THRUST (KIPS) SA-19	SEA LEVEL PUMP SPEED (rpm) SA-18	SEA LEVEL PUMP SPEED (rpm) SA-19
H-5023	1	185.0*	187.5	6459	6525
H-5012	2	187.9	188.8	6558	6542
H-5025	3	180.5*	183.8	6347	6410
H-5026	4	184.1*	186.3	6479	6533
H-2020	5	184.9*	190.8	6534	6662
H-2022	6	184.9*	190.2	6489	6576
H-2023	7	185.3*	187.6	6448	6502
H-2024	8	184.3*	190.4	6394	6530

* Reorificed after test SA-18 (GG LOX orifice only)

Engine operation during test SA-18 was satisfactory. All engines produced thrust values within the specified limits of 188K$\pm$3 percent except engine 3 which was out of limits on the low side; however, the thrust values attained by engines 1, 4, 5, 6, 7, and 8 were on the low side of the specified limits. All engines except engine 2 were reorificed (GG LOX orifice only) prior to test SA-19.

The performance of all engines during the final static test, SA-19, is considered acceptable for launch. Each engine was within specifications and no further reorificing is recommended.

An engine system schematic is shown in FIGURE 2-1. Engine static test data are recorded in TABLES 2-1 and 2-2 for tests SA-18 and SA-19. TABLES 2-3 and 2-4 list the ignition and cutoff sequence times for tests SA-18 and SA-19. GRAPHS 2-1 through 2-16 show the oscillogram traces of the ignition and cutoff transition for each engine during test SA-19. GRAPH 2-17 shows a plot of engine 1 turbopump No. 8 bearing temperature recorded during test SA-19. The engine pressure switch settings, regulator pressure settings, and orifice sizes may be found in APPENDIX E, TEST DATA SHEET - STTE, test SA-18 and test SA-19.

Additional pertinent data, which is classified, is contained in the Confidential Supplement, Stage S-I-9, Tests SA-18 and SA-19. These data include the tabulated chamber pressures, plots of the site and sea level chamber pressures versus turbopump speed, a table which compares the hardwire chamber pressure measurements 4.51 with the telemetered chamber pressure measurements D1, and the telemetry X-Y plots of chamber pressure measurements D1-1 through D1-8, respectively, test SA-19.

An auxiliary LOX dome purge was added to stage S-I-9 prior to test SA-18 in an attempt to eliminate contamination on the LOX domes and injectors of the inboard engines. A separate purge manifold, with two supply lines, was installed for inboard engines only. One supply line is for the regular 250 psig LOX dome purge and the second supply line is for the 650 psig auxiliary LOX dome purge that is activated at inboard engine cutoff signal. Memo R-P&VE-PA-64-M-104 specifies the amount of purge pressure to be supplied at the stage interconnect point and the time that the purge was to be initiated. The 650 psig auxiliary LOX dome purge solenoid was energized at inboard engine cutoff signal for both tests (the regular LOX dome purge solenoid is energized prior to ignition command signal and is held in check by means of a check valve during the test). The purge pressure at the customer connect panel on engine 8 attained approximately 80 percent of stabilized pressure 3 seconds after inboard engine cutoff signal for test SA-18, and 90 percent of stabilized pressure at outboard engine cutoff signal for test SA-19. The purge pressure at the customer connect panel stabilized at 180 psig after both tests. During previous long duration tests with only the 250 psig purge employed, the purge pressure at the customer connect panel was 70 psig.

Prior to test SA-19, a visual inspection of the LOX dome and injector was made on engines 1, 5, and 6 with no contamination noted. Post-test inspection of the LOX domes and injectors on all inboard engines revealed contamination with carbon deposits. The degree of contamination found was approximately the same as that found in the engines of stage S-I-7 which were checked and found to be within the Rocketdyne specification limits. No corrective action is recommended. Further study is in process for increasing the effectiveness of the auxiliary LOX dome purge.

The fuel pump outlet pressure traces for the outboard engines have shown an unusual characteristic during static test on the past stages. Instead of a gradual pressure buildup as the pumps accelerate, these traces have indicated a sharp increase in pressure several hundred milliseconds after ignition command. This condition, which was attributed to the location of these transducers being in close proximity to the LOX pumps, does not occur on the inboard engine traces, since the boattail heating ducts exhaust directly on these transducers. Prior to test SA-18, each outboard engine fuel pump outlet pressure transducer was insulated from its LOX pump mounting bracket. The response of these transducers during ignition transition was normal during tests SA-18 and SA-19; therefore, it appears that insulating these transducers from the mounting brackets has remedied the problem.

No adverse hardware effects were noted, after test SA-19, as a result of the LOX depletion cutoff. Momentary recovery from LOX pump cavitation was indicated by an increase in LOX pump outlet pressure and combustion chamber pressure on engine 4 approximately 10 milliseconds after outboard engine cutoff signal. Combustion chamber pressure chugging commenced at outboard engine cutoff signal plus 190 milliseconds and at a combustion chamber pressure of 225 psig. The oscillations reached a maximum frequency of 150 cps and a maximum amplitude of 75 psig. Chamber pressure oscillation diminished almost entirely in approximately 250 milliseconds. The engine 4 cutoff parameters are shown in GRAPH 2-8.

Evaluation of the oscillograph data indicated that LOX depletion had also commenced at engines 2 and 3 prior to initiation of the outboard engine cutoff signal. The decay in combustion chamber pressure on engines 2 and 3 began 150 milliseconds and 85 milliseconds, respectively, prior to the outboard engine cutoff signal and decayed to 90 percent of mainstage pressure in 100 milliseconds and 80 milliseconds, respectively.

The combustion chamber pressure (measurement 4.51) on engine 1 failed to indicate during test SA-18. Investigation revealed that the calibration valve for this transducer was left in the calibrating position, thus isolating the transducer from sensing combustion chamber pressure. A satisfactory chamber pressure measurement was obtained from this engine by measurement 54.51.

The gearcase pressure traces at engines 3 and 5 were "hashy" from ignition to cutoff on test SA-18 (both were steady before and after the test). The average low and high gearcase pressure on both engines was 3.2 to 3.5 psig and 3.9 to 4.7 psig, respectively. Both engines experienced (not simultaneously) a momentary low spike to 1.6 psig. The gearcase relief valves on both of these engines were examined after the test and found to be in good condition and operating normally. For static test, measurement 2.01 flight transducers are replaced with Wiancko transducers to overcome compatibility problems which exist between the flight transducers and blockhouse recording equipment. The clamps holding these Wiancko transducers were examined and found to be slightly loose. It was suspected that vibration of the transducers on these two engines (3 and 5) caused the "hashy" traces. Prior to test SA-19, all gearcase pressure transducers were more rigidly secured, using an improved clamp. As a result, no "hashy" indications were recorded during the full duration test.

The fuel pump inlet pressure trace for engine 2 failed to indicate during test SA-18. Investigation revealed a broken lead on the electrical connector at the transducer. This was repaired prior to test SA-19 and functioned properly.

Random fluctuations were obtained from the fuel pump inlet pressure transducers (measurement 52.06) at engines 1, 5, and 7, and also from the LOX pump inlet pressure transducers (measurement 52.07) at engines 2, 4, 5, and 8 during test SA-18. It was suspected that these random fluctuations were due to moisture in the electrical connectors. Prior to test SA-19, "moisture proof" connectors were installed on all LOX and fuel pump inlet pressure transducers in an effort to eliminate the problem of moisture shorting out these connectors. However, random fluctuations were recorded from LOX pump inlet pressure transducers on engines 2, 4, and 8 during test SA-19. These fluctuations indicate a problem still exists and that further investigation is required.

The LOX pump inlet temperature pickups on engines 1 and 4 failed to indicate properly after X+18 and X+6 seconds, respectively, on test SA-18. Investigation revealed that the indication malfunction at engine 1 was due to failure of the temperature sensor (P/N 50M10412). This sensor was replaced prior to test SA-19. The indication malfunction at engine 4 was due to a loose connection in the electrical circuitry. Both pickups indicated properly for test SA-19.

The turbopump No. 8 bearing temperature trace indicated irregular fluctuations on five of the eight engines during test SA-19. These temperature fluctuations commenced on engines 1, 2, 4, 7, and 8 at ignition command + 70, 48, 48, 54, and 46 seconds, respectively. This condition, which indicates outer race rotation, has been experienced previously and is not considered detrimental to engine operation. GRAPH 2-17 shows a plot of engine turbopump No. 8 bearing temperature with zero time referenced from ignition command.

On test SA-19, the lube oil No. 1 bearing pressure trace for engine 6 indicated a gradual rise to operating pressure, 115 psig, from ignition command to ignition command + 8.8 seconds. After cutoff, the recorder indicated the same pressure decay rate. Post-test checkout revealed that the response drive unit in the strip chart recorder was slow in responding to the input signal, thus causing the erroneous indication.

Because of possible GG LOX injector fuel contamination found on stage S-I-6, it was requested by MSFC P&VE (reference Memo R-P&VE-PA-64-M-447) that certain preventive action be taken on stage S-I-9 prior to removing it from STTE. A meeting was subsequently held with representatives from Propulsion and Vehicle Engineering Laboratory, Quality Assurance and Reliability Laboratory, Test Laboratory, Rocketdyne, and Chrysler Systems Static Test Branch. As a result of this meeting (reference Memo R-TEST-SBT-#6-64), the seal plate assembly, P/N NA5-26702, and test seal plate, P/N C-SSTB-2024, were installed at the fuel bootstrap line to inlet manifold flange on each engine of stage S-I-9 prior to the stage being removed from STTE. These plates were installed after all possible fuel was drained from the bootstrap line. Similar action will be taken on stage S-I-8. Stage S-I-10 will incorporate specially fabricated seal plates, Rocketdyne P/N 303966. The incorporating of the seal plate at the fuel bootstrap line to inlet manifold flange following static test firing should prevent trapped residual fuel from entering and contaminating the GG LOX injector while the stage is in the horizontal position. It was recommended that on Chrysler built stages, the post-static firing checkout of the fuel bootstrap line and gas generator control valve be made while the stage is vertical in the static test stand and that further checkout should not be made until the stage is again vertical at Cape Kennedy. This would eliminate the possibility of releasing fuel from the top side of the control valve fuel poppet (while the stage is horizontal) into the conisphere where further handling in the horizontal position could cause GG LOX injector contamination. These procedures are further delineated in Chrysler ICC memo T-297 to J. F. Patrick, CCSD Michoud, from P. F. Fahey, Jr., CCSD, Huntsville.

The following is a description of the pretest and post-test checks performed on stage S-I-9.

Test SA-18

Pretest leak and hardware checks were conducted on the engines with the following results:

1. An external thrust chamber tube dent was incurred on engine 1 prior to delivery of the stage to Static Test Tower East. This dent was located approximately 180° from the fuel inlet manifold flange and 3 inches below the throat. The size of this dent was well within acceptable limits of one-half the tube diameter. However, due to the sharpness of the dent, sweat braze material was used to build up and reinforce the dented area. Reference Inspection Report MM-352.

2. An external thrust chamber tube dent was also incurred at engine 1 during the installation of the heat shield curtain at Static Test Tower East. This dent was located in line with the fuel inlet manifold flange and approximately 18 inches below the throat. Since this dent was not sharp and was well within the acceptable limits, no corrective action was taken.

3. The Thrust OK pressure switches (measurement 96.11) at engines 2 and 3 had damaged electrical connectors. Also, a damaged electrical connector was found on the calibration valve for the GG LOX injector pressure transducer (measurement 4.02) at engine 2. The damaged pressure switches and valve were removed and replaced by new components. Reference Inspection Reports MI-932, MI-935 and KF-999.

4. During the propellant loading test, fuel leakage was discovered at the connection between the fuel high-pressure bleed line (P/N 20M51035) and the bulkhead union (P/N MC164C4) at engine 7. The copper crush seal which was used at this connection was evidently damaged during installation. Also, the sealing surface of the bulkhead union was oval in shape. The bulkhead union was replaced, thus correcting the leak. Reference Inspection Report KK-386.

5. During thrust chamber leak checks (using GN_2) slight fuzz leakage was observed at the three tapped holes in the LOX dome outer bolt circle on engine 2 (S/N H-5012). These leaks were also observed during leak checks at Manufacturing Engineering Laboratory, and corrective action was deemed unnecessary.

6. Thrust chamber tube leak checks with fuel revealed the following internal leakage:

ENGINE	LEAKAGE RATE	LEAKAGE ELEVATION	LEAKAGE LOCATION IN DEGREES COUNTERCLOCKWISE FROM FUEL INLET, AFT LOOKING FORWARD
5*	Very slight seep	4 inches below throat	150°
6	Very slight seep	5 inches below throat	90°
7	Slightly damp	6 inches above return manifold	0° & 180° (2 leaks)

* Leakage occurred at an area which had previously been repaired.

7. The LOX pump inlet pressure transducers (measurement 2.07) on all engines were damaged by over-pressurization during transducer calibrations. Since new flight pressure transducers could not be obtained in time, Wiancko transducers were installed for this test.

Post-test hardware inspection and leak checks were conducted on the engines with the following results:

1. Prior to post-test turbopump preservation, turbopump torque checks of all engines were started. The turbopump at engine 3 was torqued to 250 in.-lbs. and did not breakaway. The pump was then torqued in the opposite direction and broke away at 180 in.-lbs. It was immediately turned in the proper direction and had a breakaway torque of 80 in.-lbs. and a running torque of 75 in.-lbs. It is probable that carbon deposits between the carbon seal and turbine shaft caused this initial high breakaway torque.

2. A visual inspection of the thrust chamber injectors revealed a piece of safety wire protruding from one of the LOX injector orifices on engine 6. This LOX injector orifice is located approximately 130° from the fuel inlet manifold flange (measured in a clockwise direction, forward looking aft) and in the fourth LOX injector ring from the chamber wall. The safety wire was broken when an attempt was made to remove it. A small piece of the wire was left in the orifice. The downstream side of the main LOX valve gate was examined with an inspection mirror to determine integrity of the safety wire on the bolts which secure the valve gate to its shaft. The safety wire on the main LOX valve was intact. The origin of the wire protruding from the LOX injector orifice is unknown. Further action will not be taken, since the wire in the orifice does not present a hazard to subsequent engine operation.

3. During the gas generator and turbine exhaust system leak checks, leakage was observed at the turbine inlet flange connection on engines 2 and 3. Torque checks revealed one undertorqued flange bolt in the area of leakage on both engines. The leak check was repeated after all bolts on these flanges had been torqued to the maximum value, and no leakage was observed on either engine.

4. Following post-test turbopump preservation, the gearcase pressure at engines 6 and 7 dropped to 0 and 1 psig, respectively. An inspection of the gearcase pressure relief valves revealed a carbon particle under the valve poppet at engine 6 and excessive preservative oil in the relief valve at engine 7. After cleaning the relief valves the gearcase pressures returned to normal.

5. A visual inspection after the test revealed possible fuel leakage in the area of the gas generator control valve to gas generator combustion chamber connection flange at engine 8. This led to a 650 psig leak check of the gas generator control valve and fuel bootstrap line and a complete gas generator and turbine exhaust system leak check. No leakage was found.

6. Thrust chamber tube leak checks with fuel revealed the following internal leakage:

ENGINE	LEAKAGE RATE	LEAKAGE ELEVATION	LEAKAGE LOCATION IN DEGREES COUNTERCLOCKWISE FROM FUEL INLET, AFT LOOKING FORWARD
2	Very slight seep	1 inch above return manifold	15^{o} & 20^{o} (2 leaks)
5	Very slight seep	4 inches below throat	150^{o}
8	Very slight seep	2 inches below throat	200^{o}

Test SA-19

Pretest leak and hardware checks were conducted on the engines with the following results:

1. During the gas generator and turbine exhaust system leak checks, leakage was observed at the turbine inlet flange connection on engine 2. This leak was also observed during SA-18 post-test leak checks, but appeared to cease when the fasteners at this connection were torqued to the maximum value. A new Flexitallic gasket (P/N 8-3054-IPNA) was installed at this turbine inlet flange connection thus correcting the leakage. Reference Inspection Report No. KK-389.

2. New LOX pump inlet pressure transducers (P/N 50M10026), measurement 2.07, were installed on all engines prior to this test. The rejected transducers for this measurement were damaged by overpressurization prior to test SA-18, but could not be replaced at that time since new transducers were not available. Reference Inspections Reports No. KL-860, KL-864, KL-865, KL-867, KL-868, KL-869, KL-870, and KL-871.

3. While filling thrust chambers with fuel for test SA-19, leakage was observed at one of the return manifold drain screws on engine 6. After draining the fuel and replacing the drain screw copper seal (P/N RD153-0116-0004), this thrust chamber was refilled with no leakage being observed.

4. The swivel elbow (P/N 4C6BX-SS), which is located in the fuel high-pressure bleed system on engine 4, was replaced due to a lost B-nut retainer pin. Reference Inspection Report No. KF-919.

5. Visual inspection revealed a rusty lock nut (P/N RD114-1003-1004) at the connection between the gas generator LOX purge fitting (P/N 307410) and injector assembly at engine 5. Apparently the material used in manufacturing the lock nut does not meet the proper specification. This lock nut will be replaced when the stage returns to Manufacturing Engineering Laboratory. Reference Inspection Report No. KF-917.

6. Thrust chamber tube leak checks with fuel revealed the following internal leakage:

ENGINE	LEAKAGE RATE	LEAKAGE ELEVATION	LEAKAGE LOCATION IN DEGREES COUNTERCLOCKWISE FROM FUEL INLET, AFT LOOKING FORWARD
2	Very slight seep	1 inch above return manifold	15° & 20° (2 leaks)
5	Very slight seep	4 inches below throat	150°

Post-test hardware inspection and leak checks were conducted on the engines with the following results:

1. While performing the gas generator and turbine exhaust system leak checks, leakage was observed at the turbine inlet flange connection on engines 4 and 6. Torque checks revealed that all of the fasteners at these connections were near the lower specified limit (165-172 inch-pounds). The leak check was repeated after all of the fasteners at these connections had been torqued to the maximum value and no leakage was observed on either engine.

2. Visual inspection of the thrust chamber injector baffles revealed metal shavings protruding from the hypergol orifice in compartment C4 (180° from the hypergol manifold) of engine 2. The shavings were removed and examined in an attempt to determine their origin. It appears that these shavings might be caused by drilling of the injector hypergol passage. Since no injector damage was observed, no further action will be taken concerning this matter.

3. Following post-test turbopump preservation, turbopump torque checks were begun on all engines. The initial breakaway torque for the turbopumps at engines 3, 5, 7, and 8 were high. Carbon deposits between the carbon seal and turbine shaft may cause these initial high breakaway torques. After rotating the shafts one complete revolution, the breakaway and running torques were normal. The torque values recorded for these engines are as follows:

ENGINE	INITIAL BREAKAWAY TORQUE (INCH-POUNDS)	BREAKAWAY TORQUE AFTER ROTATION (INCH-POUNDS)	RUNNING TORQUE (INCH-POUNDS)
3	165	80	70
5	210	65	60
7	200	60	55
8	190	60	55

4. During gaseous thrust chamber leak checks, slight leakage was observed at the three tapped holes in the outer LOX dome bolt circle on engine 2. These holes are used for attachment of the LOX dome removal tool. Small "fuzz" leaks have been observed at these holes during each thrust chamber leak check at Test Laboratory and Manufacturing Engineering Laboratory. Since the leakage rate is small and appears to be unchanged, no corrective action is deemed necessary.

5. Visual inspection following test SA-18 revealed the possibility of fuel leakage in the area of the gas generator control valve to gas generator combustion chamber flange connection. It was suspected that fuel spilled on this flange connection during pretest checkouts was washed out by melting frost, giving the appearance of fuel leakage. Prior to test SA-19, all gas generators were thoroughly washed and dried, and post-test inspections revealed no evidence of fuel leakage.

6. Thrust chamber tube leak checks with fuel revealed the following internal leakage:

ENGINE	LEAKAGE RATE	LEAKAGE ELEVATION	LEAKAGE LOCATION IN DEGREES, COUNTERCLOCKWISE FROM FUEL INLET, AFT LOOKING FORWARD
2	Very slight seep	1 inch above return manifold	15° & 20° (2 leaks)
3	Very slight seep	13 inches below injector	10°
7	Seep	12 inches below throat	90°

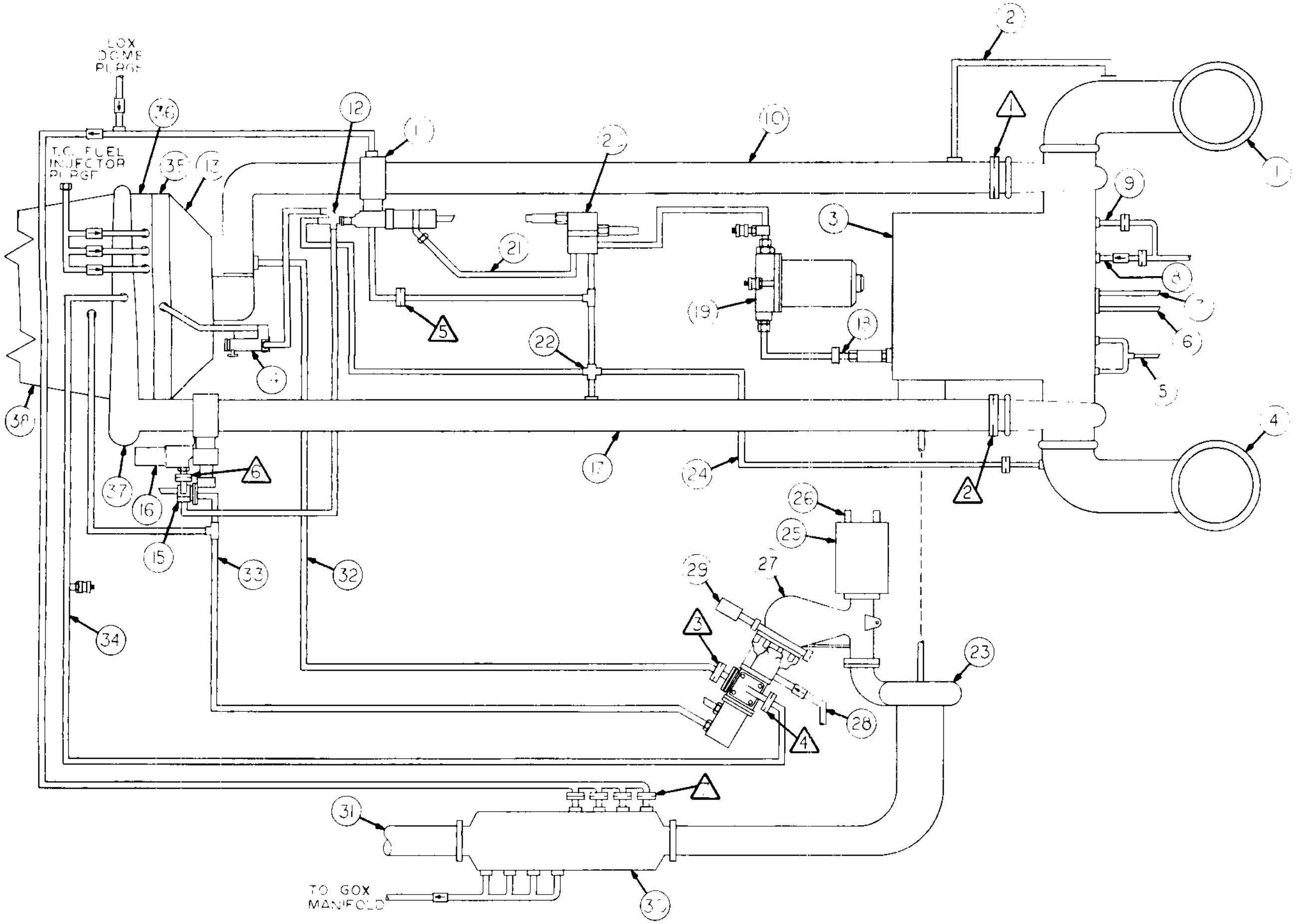


FIGURE 2-1 H-1 ENGINE SCHEMATIC

FIND NO	ITEM
1	LOX SUCTION LINE
2	LOX BLEED LINE
3	TURBO PUMP
4	FUEL SUCTION LINE
5	LUBE DRAIN
6	LUBE SEAL DRAIN
7	LOX SEAL DRAIN
8	GEAR BOX PRESS
9	LOX SEAL PURGE
10	LOX HIGH PRESS DUCT
11	MAIN LOX VALVE
12	IGNITER FUEL VALVE
13	LOX DOME
14	HYPERGOL CONTAINER
15	IGNITION MONITOR VALVE
16	MAIN FUEL VALVE
17	FUEL HIGH PRESS DUCT
18	T/P LUBE LINE
19	FABU
20	CONAX VALVE
21	MAIN LOX VALVE CLOSING CONTROL LINE
22	FUEL CONTROL CROSS
23	2-STAGE TURBINE
24	FUEL BLEED LINE
25	SOLID PROPELLENT GAS GENERATOR
26	SPGG INITIATORS
27	LIQUID PROPELLENT GAS GENERATOR
28	GG LOX INJECTOR PURGE
29	GG AUTO IGNITERS
30	HEAT EXCHANGER
31	TURBINE EXHAUST DUCT
32	LOX BOOTSTRAP LINE
33	CONTROL LINE
34	FUEL BOOTSTRAP LINE
35	LOX INJECTOR
36	FUEL INJECTOR
37	FUEL MANIFOLD
38	COMBUSTION ZONE

ORIFICES

1	MAIN LOX
2	MAIN FUEL
3	GG LOX
4	GG FUEL
5	MLV CONTROL
6	MFV CONTROL
7	HEAT EXCHANGER (TYP 3 PLACES)

TABLE 2-1
ENGINE STATIC TEST DATA

Ambient Press. (psia)	14.4
Ambient Temp. (°F)	67.0

TEST SA-18

MEASUREMENT	MEAS. NO.	ENGINE	VALUES AT IGNITION	VALUES AT AVERAGE 29-32 sec.	VALUES AT CUTOFF
Press. Fuel Pump Inlet (psig)	2.06 (D-12)	1	38.8	30.4	
		2	39.3	30.7	
		3	39.2	30.8	
		4	39.4	30.7	
		5	39.0	31.3	
		6	38.6	30.0	
		7	38.3	30.5	
		8	38.7	31.2	
Temp. Fuel Pump Inlet (°F)	13.01	8	48.5	45.2	
Density of Fuel at pump inlet (lbs./cu.ft.)		8		50.8	
Press. Fuel Pump Outlet (psig)	5.51	1		899.7	
		2		914.1	
		3		869.4	
		4		907.8	
		5		916.0	
		6		909.6	
		7		849.7	
		8		858.3	
Press. LOX Pump Inlet (psig)	2.07 (D-13)	1	76.0	54.7	
		2	74.0	53.0	
		3	73.8	53.7	
		4	74.2	53.3	
		5	72.2	52.1	
		6	74.5	54.3	
		7	74.5	54.1	
		8	75.0	55.2	
Temp. LOX Pump Inlet (°F)	19.01	1	-281.6	*	
		2	-281.6	-293.2	
		3	-281.9	-292.9	
		4	-282.2	*	
		5	-281.0	-293.6	
		6	-280.9	-293.5	
		7	-281.3	-293.2	
		8	-280.1	-293.7	

* Measurement Lost

TABLE 2-1 (CONTINUED)

MEASUREMENT	MEAS. NO.	ENGINE	VALUES AT IGNITION	VALUES AT AVERAGE 29-32 sec.	VALUES AT CUTOFF
Press. Gear Case (psig)	2.01 (D-18)	1		4.4	
		2		4.0	
		3		3.9	
		4		4.1	
		5		3.9	
		6		4.5	
		7		4.3	
		8		4.0	
Turbopump Speed (rpm)	92.01	1		6422	
		2		6516	
		3		6303	
		4		6436	
		5		6502	
		6		6458	
		7		6411	
		8		6366	
Temp. Oronite (°F)	14.03 (XC89)	1	125.0		
		2	127.5		
		3	128.0		
		4	131.5		
		5	131.5		
		6	130.0		
		7	128.5		
		8	127.3		
Press. Lube Oil No. 1 Bearing (psig)	2.54 (D-20)	1		106.0	
		2		135.0	
		3		97.5	
		4		106.5	
		5		94.0	
		6		114.9	
		7		116.0	
		8		126.0	
Temp. LOX Pump No. 1 Bearing (°F)	14.01 (C1)	1	104.0	116.0	
		2	96.0	117.0	
		3	104.0	112.0	
		4	88.0	105.0	
		5	110.0	124.0	
		6	118.0	124.0	
		7	116.0	128.0	
		8	104.0	121.0	

TABLE 2-1 (CONTINUED)

MEASUREMENT	MEAS. NO.	ENGINE	VALUES AT IGNITION	VALUES AT AVERAGE 29-32 sec.	VALUES AT CUTOFF
Temp. Turbopump No. 2 Bearing (°F)	15.02	1	74.6	89.7	
		2	75.6	93.9	
		3	77.3	91.4	
		4	67.3	85.7	
		5	79.0	95.1	
		6	86.9	106.6	
		7	78.3	93.4	
		8	72.8	94.0	
Temp. Turbopump No. 4 Bearing (°F)	15.04	1	99.7	127.2	
		2	96.5	129.4	
		3	109.6	139.1	
		4	92.7	101.8	
		5	110.5	111.2	
		6	106.4	138.6	
		7	101.0	134.6	
		8	97.8	126.3	
Temp. Turbopump No. 8 Bearing (°F)	15.08	1	62.3	149	
		2	62.2	166	
		3	62.3	149	
		4	52.4	159	
		5	65.0	154	
		6	70.0	164	
		7	61.2	153	
		8	60.3	149	
Press. LOX Pump Outlet (psig)	5.52	1		739.9	
		2		788.0	
		3		746.0	
		4		758.5	
		5		692.4	
		6		774.8	
		7		766.1	
		8		744.7	
Temp. SPGG Surface (°F)	13.11	1	61.2		
		2	63.0		
		3	60.3		
		4	58.3		
		5	62.0		
		6	67.1		
		7	63.2		
		8	60.0		

TABLE 2-2
ENGINE STATIC TEST DATA

Ambient Press. (psia)	14.4
Ambient Temp. (^oF)	72

TEST SA-19

MEASUREMENT	MEAS. NO.	ENGINE	VALUES AT IGNITION	VALUES AT AVERAGE 29-32 sec.	VALUES AT CUTOFF
Press. Fuel Pump Inlet (psig)	2.06 (D-12)	1	39.3	30.1	13.7
		2	39.4	30.3	13.0
		3	39.5	30.2	13.3
		4	39.3	30.3	13.1
		5	39.2	30.2	14.1
		6	39.0	30.4	14.3
		7	39.2	30.5	14.3
		8	39.0	30.4	14.0
Temp. Fuel Pump Inlet (^oF)	13.01	8	51.8	50.1	51.6
Density of Fuel at pump inlet (lbs./cu.ft.)		8		50.65	
Press. Fuel Pump Outlet (psig)	5.51	1		925	883
		2		925	880
		3		887	872
		4		937	909
		5		953	897
		6		938	901
		7		941	895
		8		900	866
Press. LOX Pump Inlet (psig)	2.07 (D-13)	1	73.7	53.3	30.7
		2	75.0	54.8	31.1
		3	73.9	54.2	31.5
		4	73.8	53.2	31.3
		5	73.5	54.6	32.3
		6	73.4	54.6	32.8
		7	73.7	54.2	32.8
		8	73.7	54.4	33.0
Temp. LOX Pump Inlet (^oF)	19.01	1	-282.5	-293.7	-291.9
		2	-282.4	-293.7	-291.8
		3	-282.8	-293.9	-291.7
		4	-282.8	-294.2	-292.3
		5	-281.9	-294.0	-293.0
		6	-281.8	-294.0	-292.8
		7	-281.7	-294.1	-292.2
		8	-281.8	-293.8	-293.6

TABLE 2-2 (CONTINUED)

MEASUREMENT	MEAS. NO.	ENGINE	VALUES AT IGNITION	VALUES AT AVERAGE 29-32 sec.	VALUES AT CUTOFF
Press. Gearcase (psig)	2.01 (D-18)	1		4.0	
		2		4.0	
		3		4.0	
		4		4.1	
		5		4.0	
		6		4.5	
		7		4.0	
		8		4.0	
Turbopump Speed (rpm)	92.01	1		6508	6465
		2		6530	6452
		3		6399	6362
		4		6518	6489
		5		6645	6579
		6		6567	6524
		7		6493	6448
		8		6518	6475*
Temp. Oronite (^{o}F)	14.03 (XC89)	1	128.0		
		2	133.0		
		3	124.0		
		4	127.5		
		5	123.0		
		6	128.5		
		7	125.0		
		8	124.5		
Press. Lube Oil No. 1 Bearing (psig)	2.54 (D-20)	1		144.3	
		2		147.3	
		3		101.6	
		4		104.5	
		5		96.2	
		6		115.0	
		7		117.0	
		8		124.3	
Temp. LOX Pump No. 1 Bearing (^{o}F)	14.01 (C1)	1	110	120	202
		2	64	103	195
		3	74	100	187
		4	100	113	194
		5	103	122	203
		6	121	130	209
		7	116	127	200
		8	106	122	209

* This value was erroneously reported as 6254 rpm in the test SA-19 PSTR.

TABLE 2-2 (CONTINUED)

MEASUREMENT	MEAS. NO.	ENGINE	VALUES AT IGNITION	VALUES AT AVERAGE 29-32 sec.	VALUES AT CUTOFF
Temp. Turbopump No. 2 Bearing (°F)	15.02	1	68.3		162.6
		2	51.1		160.4
		3	49.5		153.5
		4	62.5		155.2
		5	62.7		167.1
		6	69.7		195.0
		7	66.4		157.5
		8	67.4		167.9
Temp. Turbopump No. 4 Bearing (°F)	15.04	1	71.1		216.0
		2	49.5		208.4
		3	52.6		205.3
		4	64.9		203.7
		5	69.1		204.9
		6	79.4		220.4
		7	70.9		210.0
		8	68.3		207.7
Temp. Turbopump No. 8 Bearing (°F)	15.08	1	67		378
		2	54		388
		3	55		371
		4	62		384
		5	71		404
		6	69		396
		7	61		389
		8	69		397
Press. LOX Pump Outlet (psig)	5.52	1		765	738
		2		800	769
		3		766	741
		4		777	748
		5		791	755
		6		789	757
		7		781	750
		8		787	743
Temp. SPGG Surface (°F)	13.11	1	57.1		
		2	57.3		
		3	55.4		
		4	57.0		
		5	58.3		
		6	68.2		
		7	55.7		
		8	55.7		

TABLE 2-3
IGNITION AND CUTOFF SEQUENCE TIMES

TEST SA-18

ENGINE	1	2	3	4	5	6	7	8
IGNITION SIGNAL FROM IGNITION COMMAND (MILLISECONDS)	325	225	325	225	24	125	24	125
TIMES FROM IGNITION SIGNAL OF EACH ENGINE IN MILLISECONDS								
MLV Starts Opening	225	230	235	260	240	250	205	240
MLV Full Open	470	485	500	495	510	485	485	490
MLV Opening Time	245	255	265	235	270	235	280	250
MFV Starts Opening	*	580	*	595	610	590	605	580
MFV Full Open	*	1180	*	1165	1220	1190	1195	1140
MFV Opening Time	*	600	*	570	610	600	590	560
Thrust Chamber Ignition	490	495	525	525	530	510	515	520
Pc Prime	795	795	810	815	845	820	820	800
Pc Reaches 90%	985	995	990	1000	1045	1050	995	980
Turbopump Prime Speed (rpm)	5298	5185	5263	5353	5288	5245	5288	5288
Conax Firing Signal*** (Seconds from Commit)	32.370	32.360	32.361	32.357	32.244	32.250**	32.244	32.240

* Measurement Lost

** Taken from GG oscillograph.

*** These times were erroneously reported in PSTR SA-18.

TABLE 2-3 (CONTINUED)

ENGINE	1	2	3	4	5	6	7	8
	TIMES FROM CONAX FIRED CUTOFF SIGNAL IN MILLISECONDS							
MLV Starts Closing	75	75	80	80	80	85	70	75
MLV Full Closed	365	360	375	440	370	360	365	345
MLV Closing Time	290	285	295	360	290	275	295	270
MFV Starts Closing	*	310	*	340	305	290	305	295
MFV Full Closed	*	1290	*	1580	1525	1225	1455	1405
MFV Closing Time	*	980	*	1240	1220	935	1150	1110
Pc Leaves Mainstage	140	110	125	120	115	110	100	115
Pc Decays to 90%	190	160	165	170	165	160	160	160
Pc Decays to 10%	380	360	365	385	355	350	365	335

* Measurement Lost

TABLE 2-4
IGNITION AND CUTOFF SEQUENCE TIMES

TEST SA-19

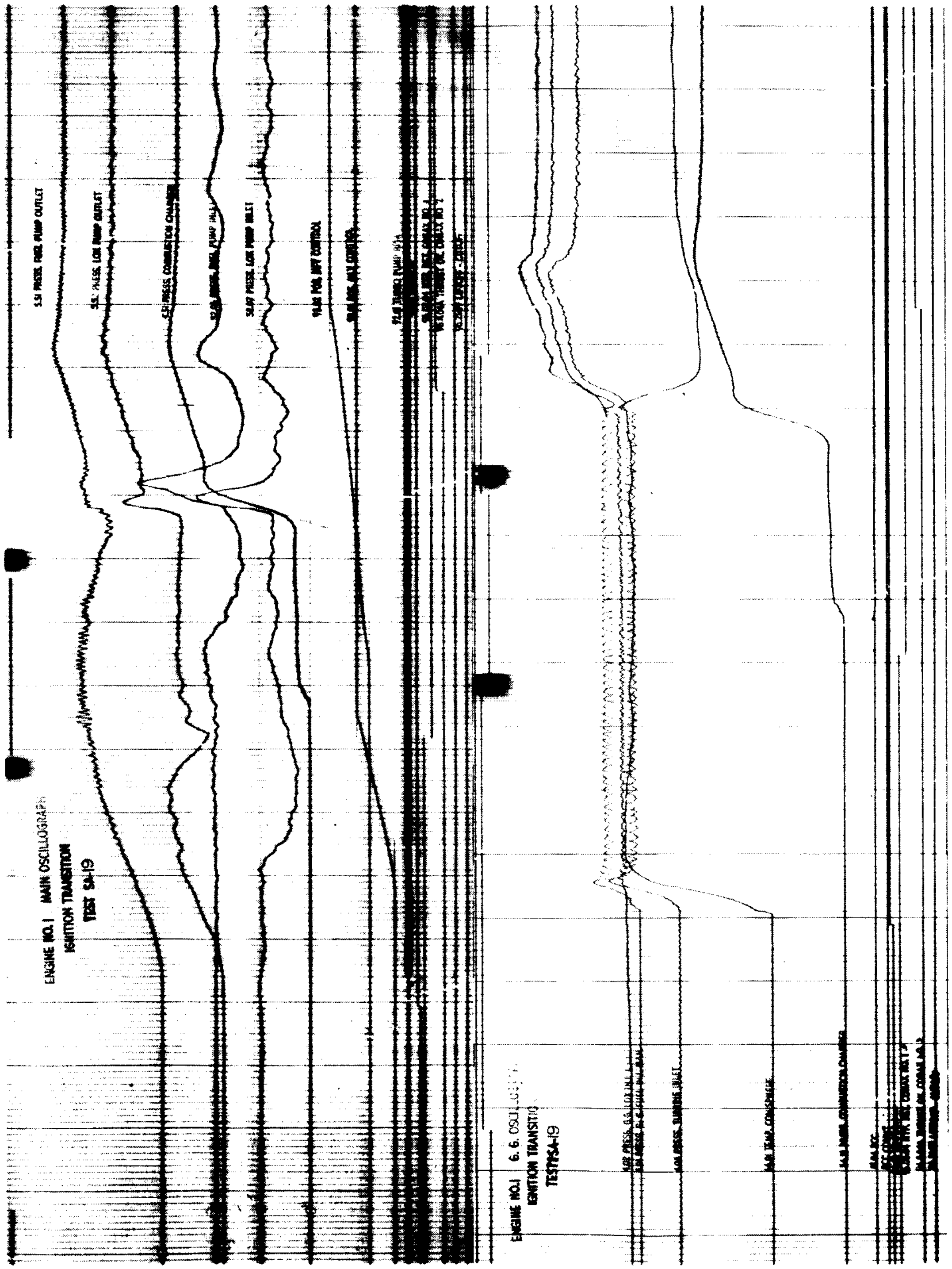
ENGINE	1	2	3	4	5	6	7	8
IGNITION SIGNAL FROM IGNITION COMMAND (MILLISECONDS)	325	225	325	225	24	125	24	125
TIMES FROM IGNITION SIGNAL OF EACH ENGINE IN MILLISECONDS								
MLV Starts Opening	195	225	205	250	225	230	215	195
MLV Full Open	455	495	475	485	475	460	485	450
MLV Opening Time	260	270	270	235	250	230	270	255
MFV Starts Opening	545	565	555	575	595	580	585	570
MFV Full Open	1100	1170	1115	1135	1175	1155	1135	1120
MFV Opening Time	555	605	560	560	580	575	550	550
Thrust Chamber Ignition	485	505	495	510	500	490	505	480
Pc Prime	765	795	775	800	805	800	800	775
Pc Reaches 90%	945	985	945	975	1015	990	985	960
Turbopump Prime Speed (rpm)	5425	5322	5263	*	5419	5298	5298	5374
Conax Firing Signal (Seconds from Commit)	142.995	142.992	142.998	142.983	139.240	139.238	139.238	139.239

* Measurement Lost

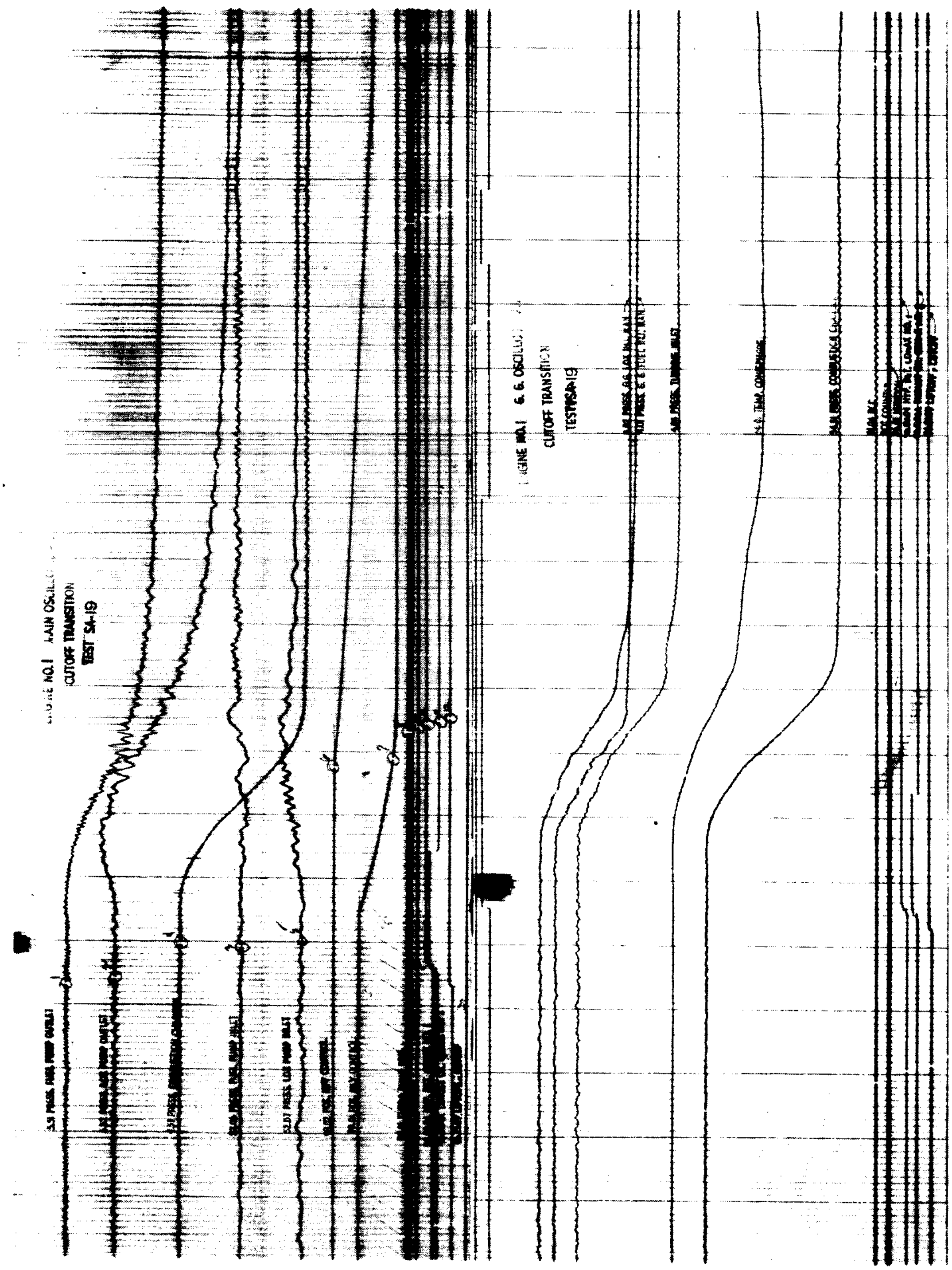
TABLE 2-4 (CONTINUED)

ENGINE	1	2	3	4	5	6	7	8
	TIMES FROM CONAX FIRED CUTOFF SIGNAL IN MILLISECONDS							
MLV Starts Closing	85	90	85	100	80	80	80	75
MLV Full Closed	405	400	395	440	395	360	365	385
MLV Closing Time	320	310	310	340	315	280	285	310
MFV Starts Closing	305	290	325	350	325	310	305	325
MFV Full Closed	1375	1350	1455	1640	1445	1220	1425	1415
MFV Closing Time	1070	1060	1130	1290	1120	910	1120	1090
Pc Leaves Mainstage	110	*-150	*-85	*-130	115	110	105	115
Pc Decays to 90%	165	*-50	*-5	*-60	165	165	160	165
Pc Decays to 10%	370	500	475	510	365	340	335	375

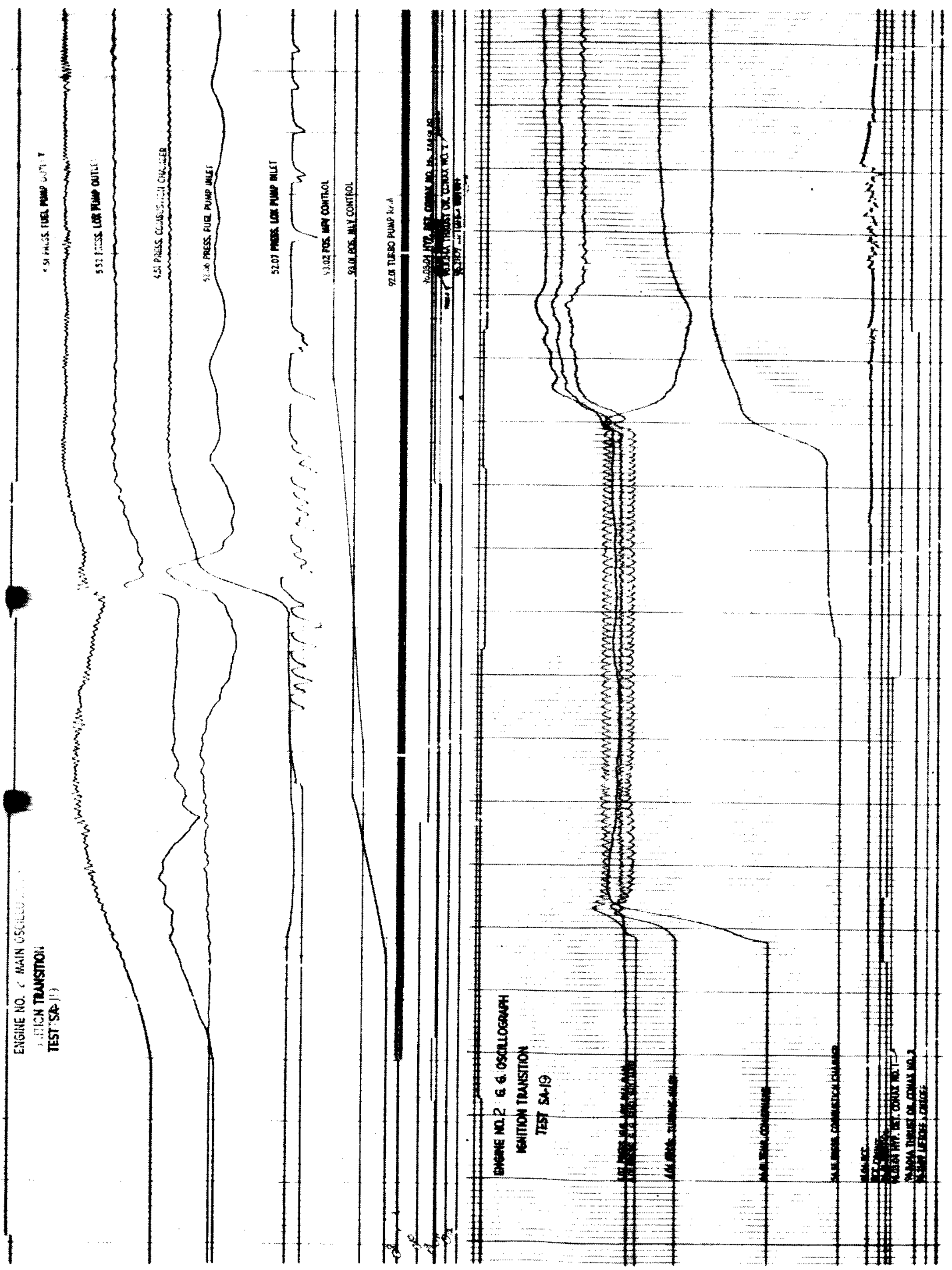
* Due to LOX depletion Pc began to decay prior to cutoff signal.


ENGINE NO. 1 MAIN OSCILLOGRAPH
IGNITION TRANSITION
TEST SA-19

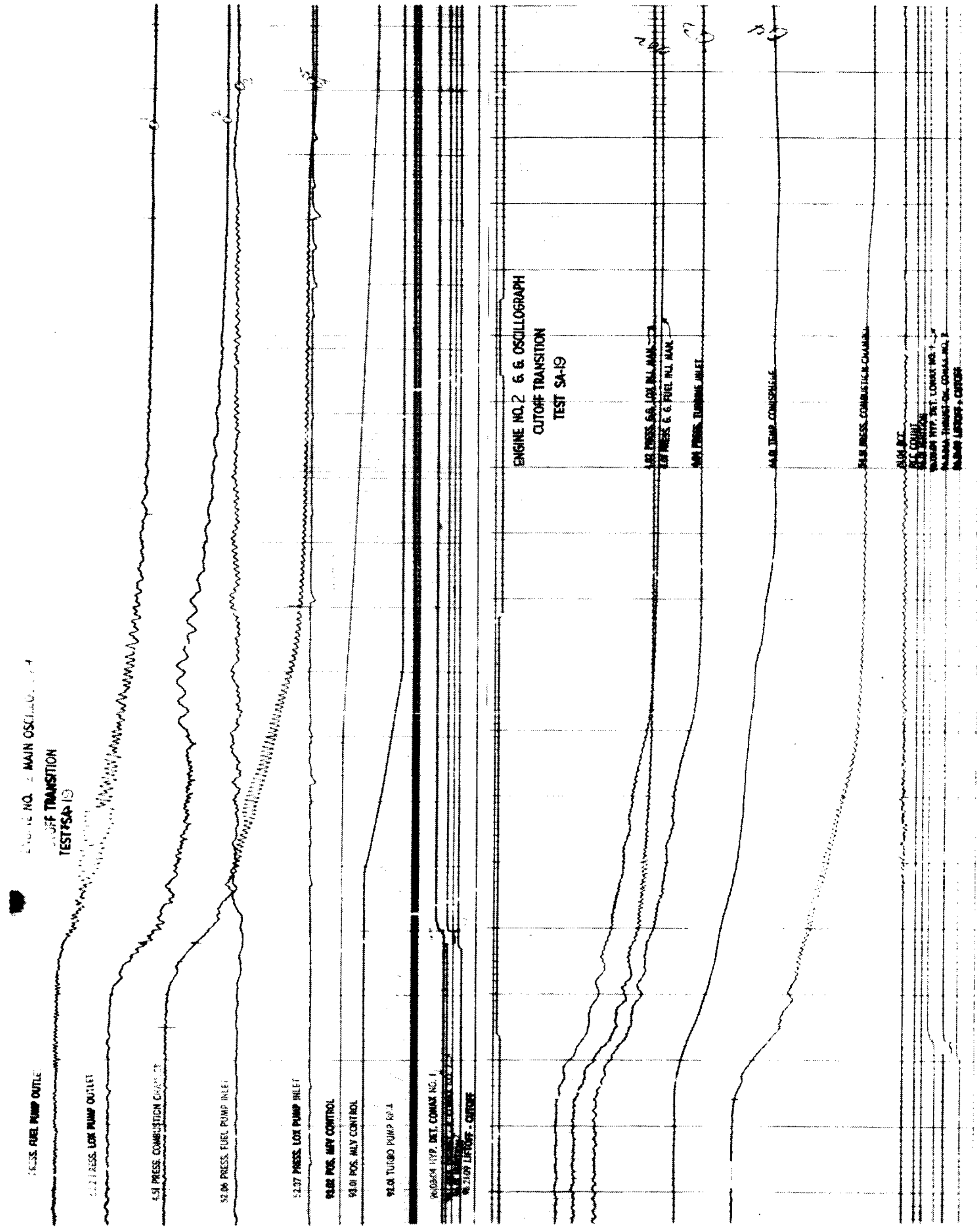
GRAPH 2-1



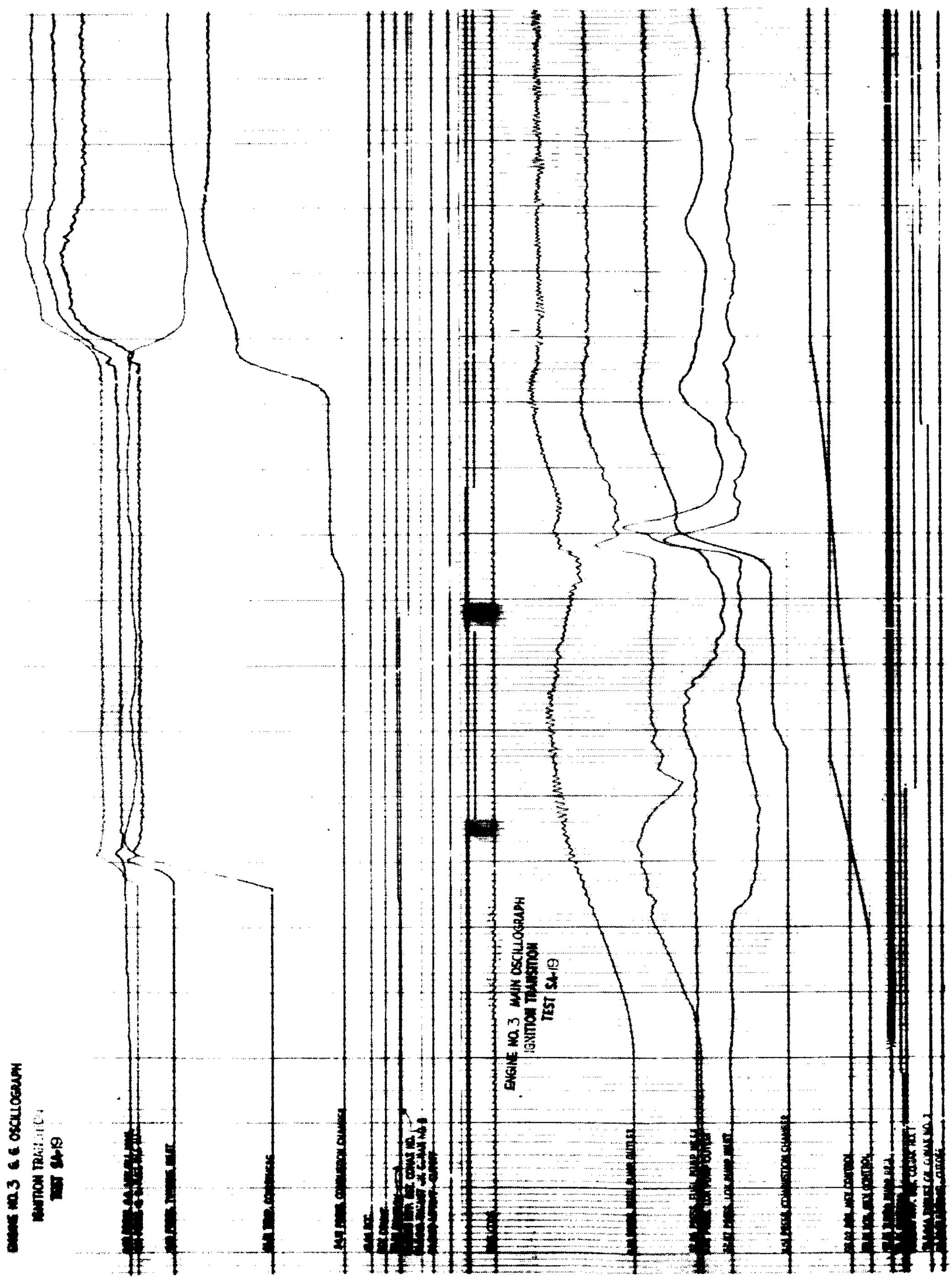
GRAPH 2-2


TEST SA-19
52.07 PRESS. LOX PUMP INLET
93.02 POS. MPV CONTROL
93.01 POS. MLV CONTROL
ENGINE NO. 2 G. G. OSCILLOGRAPH
IGNITION TRANSITION
TEST SA-19

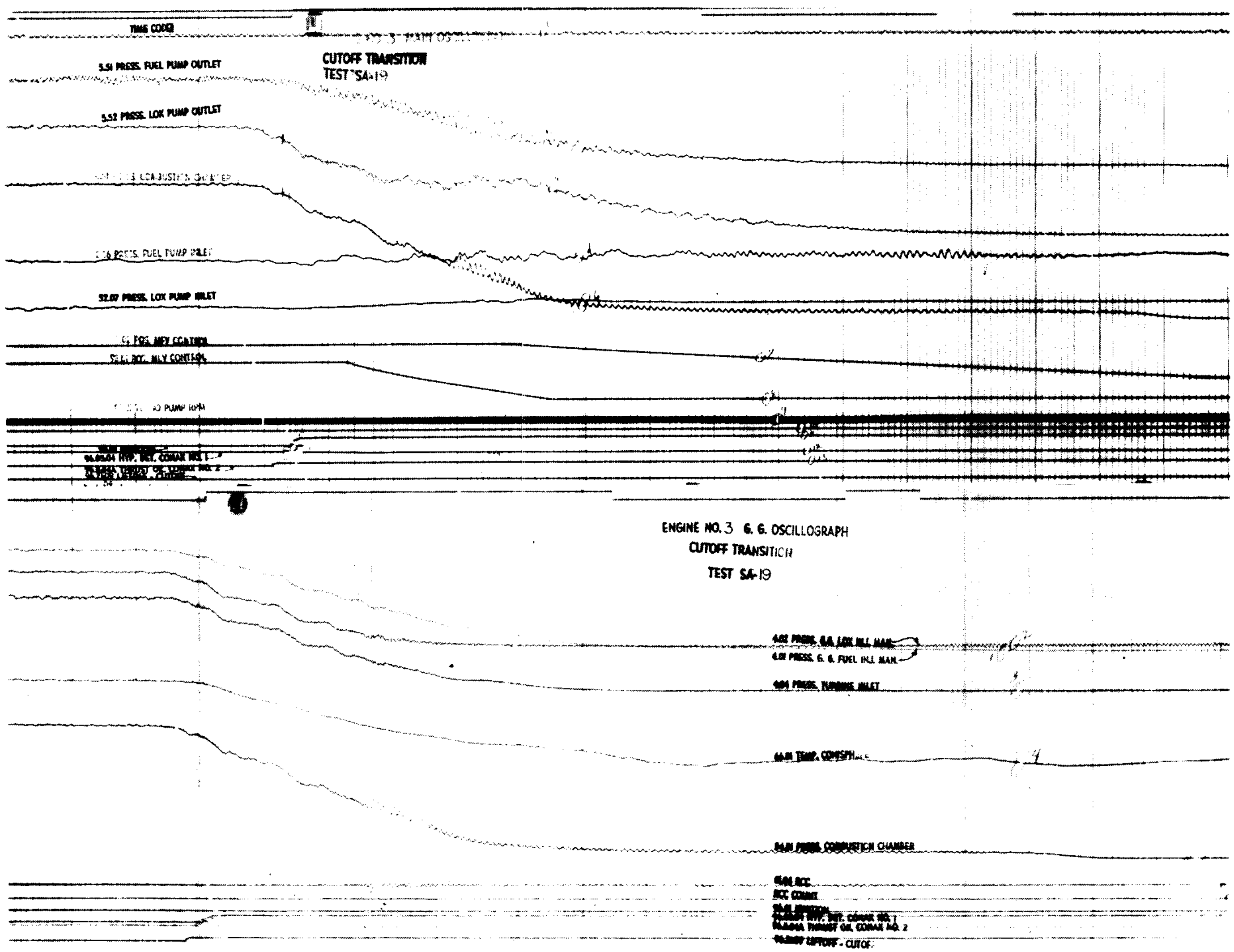
GRAPH 2-3



GRAPH 2-4

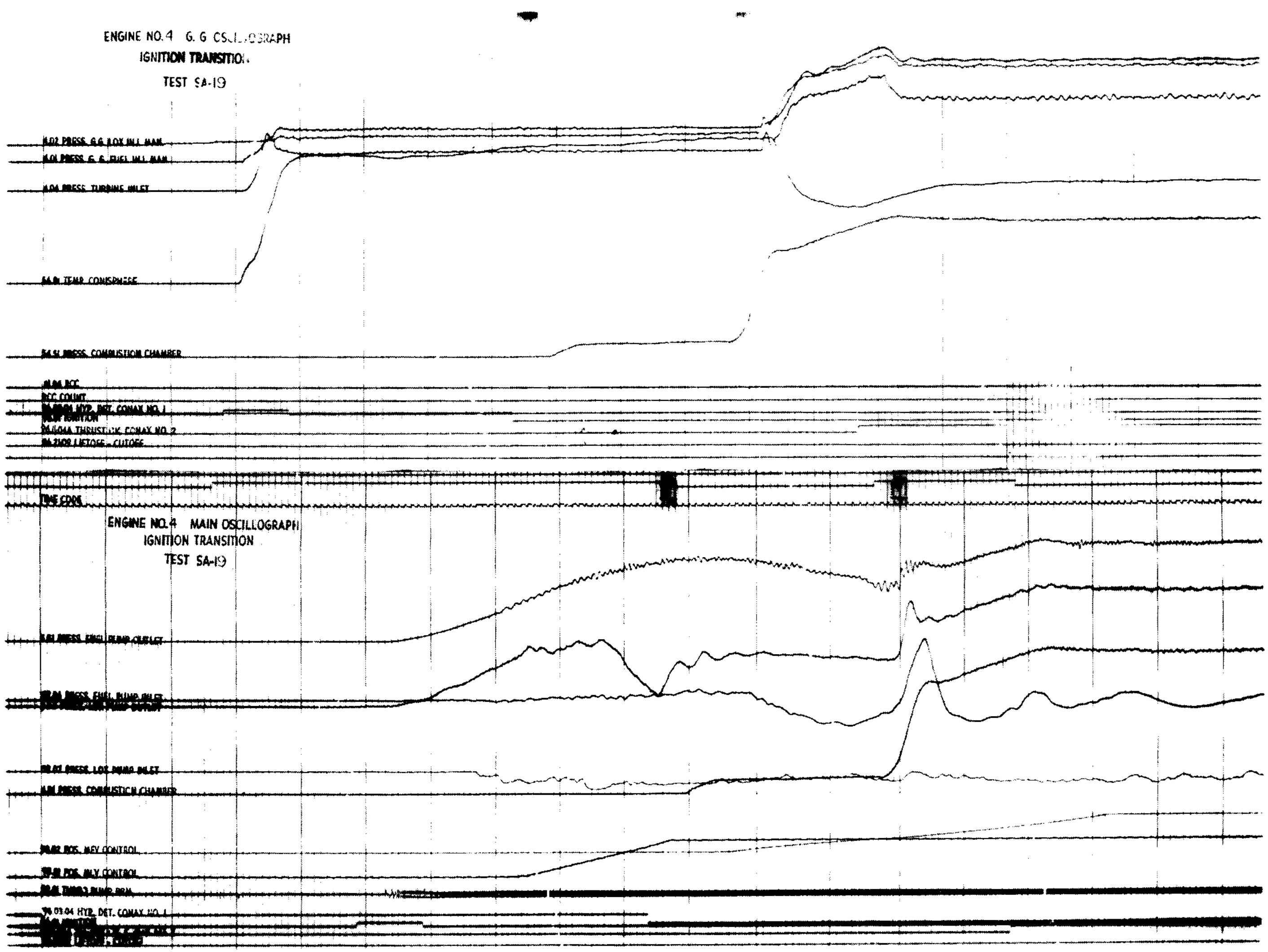

ENGINE NO.3 MAIN OSCILLOGRAPH
IGNITION TRANSITION
TEST SA-19

GRAPH 2-5

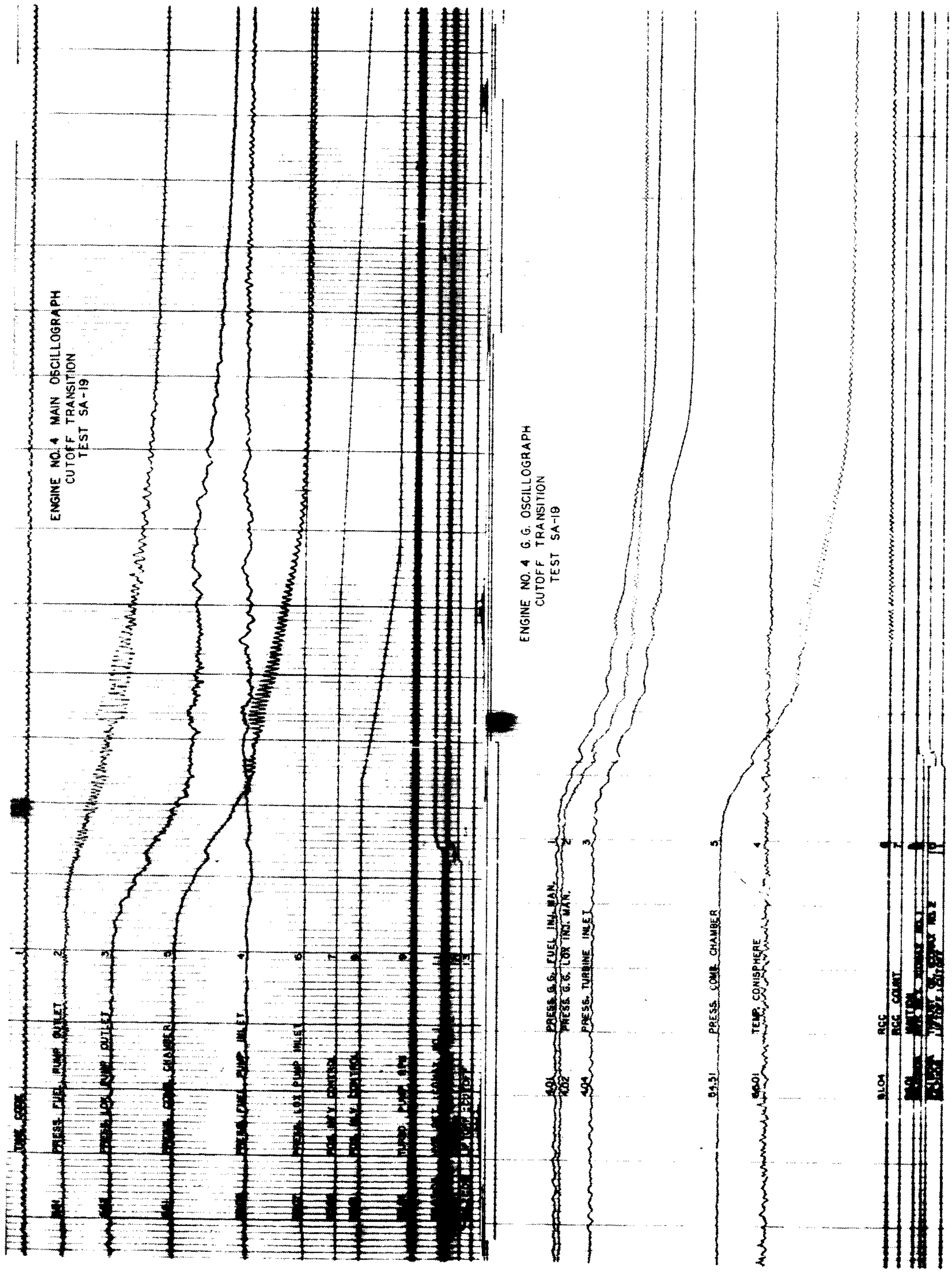


TIME CODE
5.51 PRESS. FUEL PUMP OUTLET
CUTOFF TRANSITION
TEST SA-19
5.52 PRESS. LOX PUMP OUTLET
52.07 PRESS. LOX PUMP INLET
ENGINE NO. 3 G. G. OSCILLOGRAPH
CUTOFF TRANSITION
TEST SA-19
4.01 PRESS. G. G. FUEL INJ. MAN.
PRESS. COMBUSTION CHAMBER

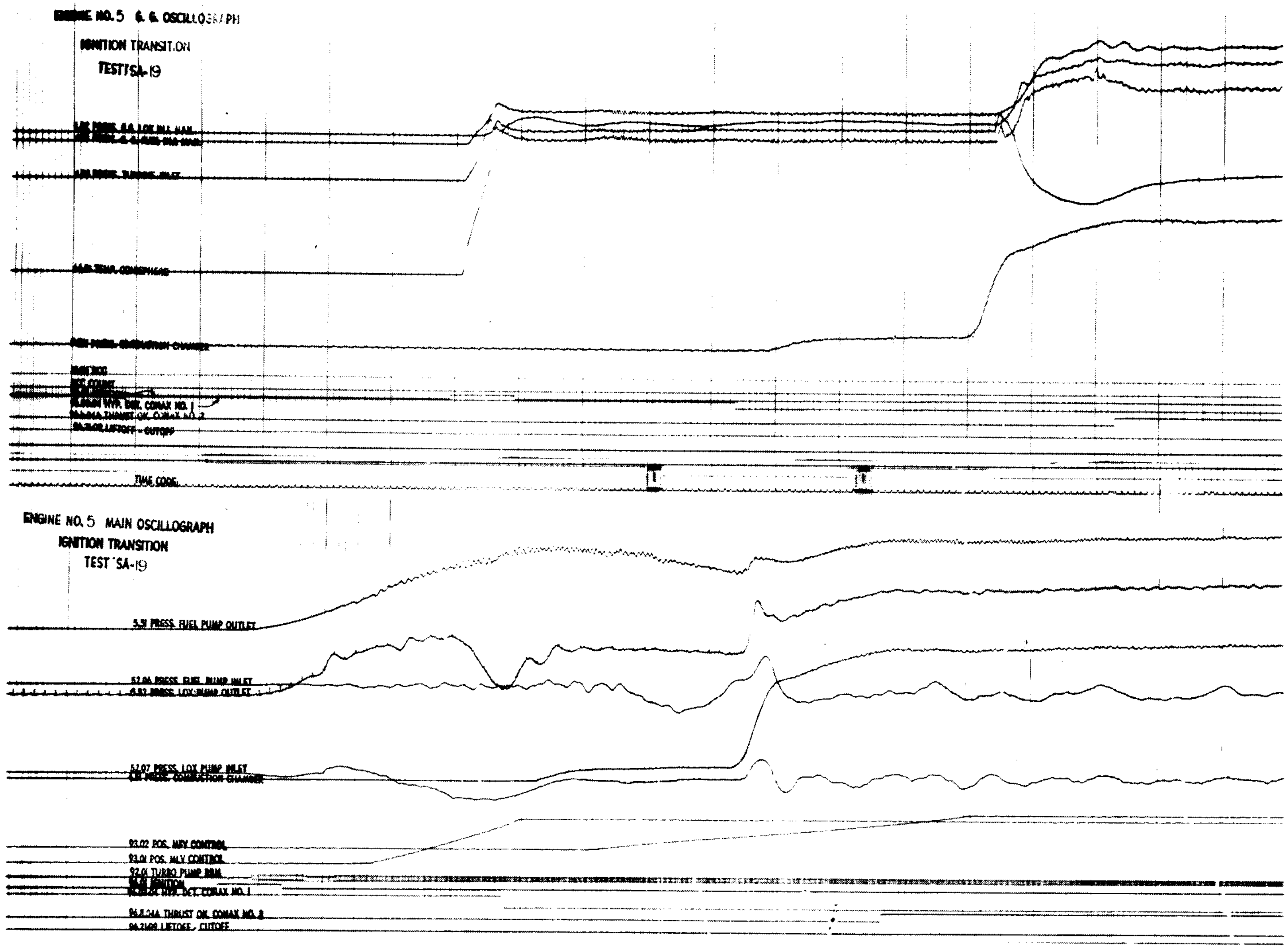
GRAPH 2-6


ENGINE NO. 4 G. G
IGNITION
TEST SA-19
ENGINE NO. 4 MAIN OSCILLOGRAPH
IGNITION TRANSITION
TEST SA-19
TIME CODE

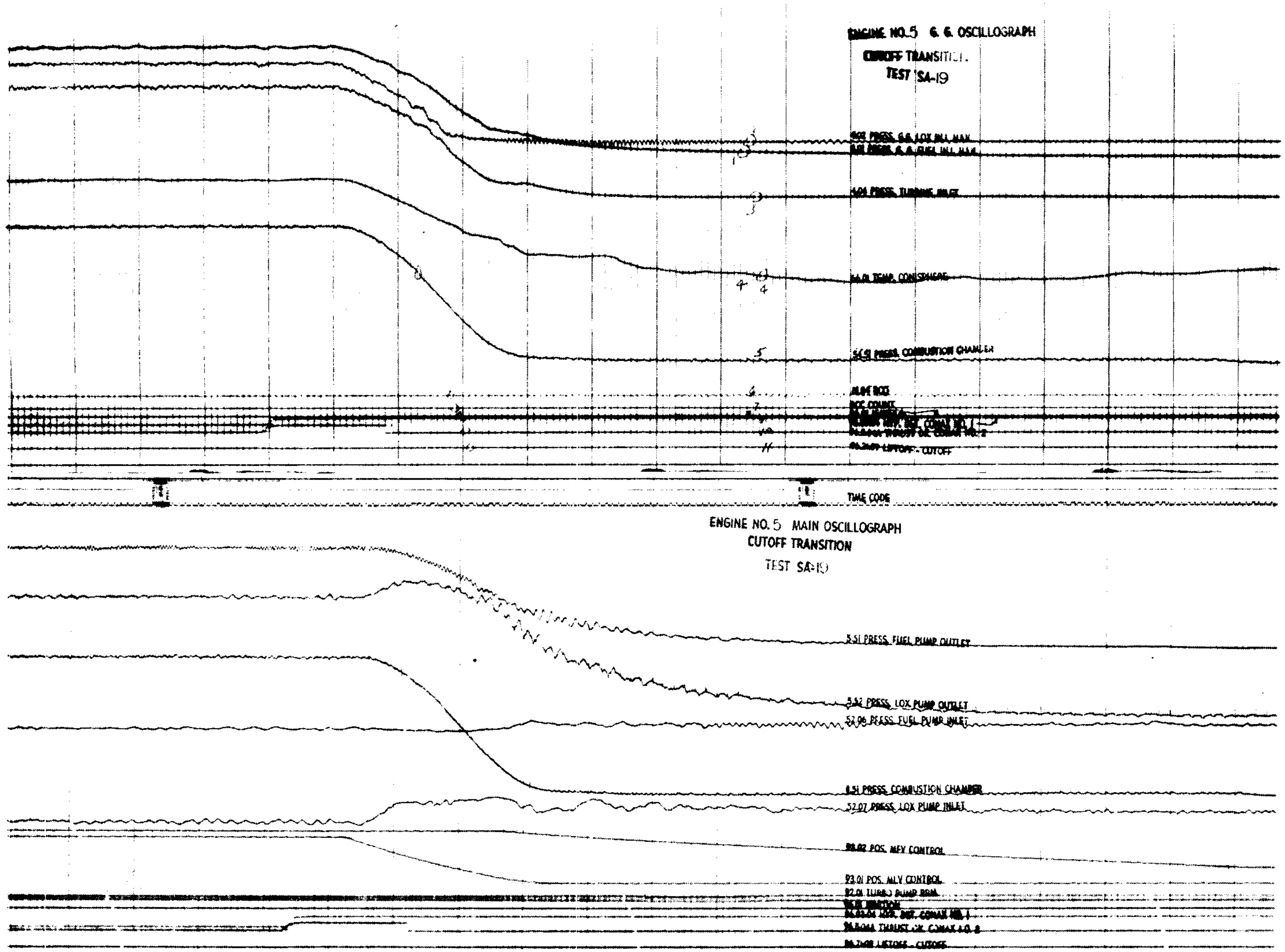
GRAPH 2-7


ENGINE NO. 4 MAIN OSCILLOGRAPH
CUTOFF TRANSITION
TEST SA-19
ENGINE NO. 4 G.G. OSCILLOGRAPH
CUTOFF TRANSITION
TEST SA-19
PRESS. FUEL PUMP OUTLET
PRESS. G.G. FUEL INJ. MAN.
PRESS. G.G. LOX INJ. MAN.
PRESS. TURBINE INLET
PRESS. COMB. CHAMBER

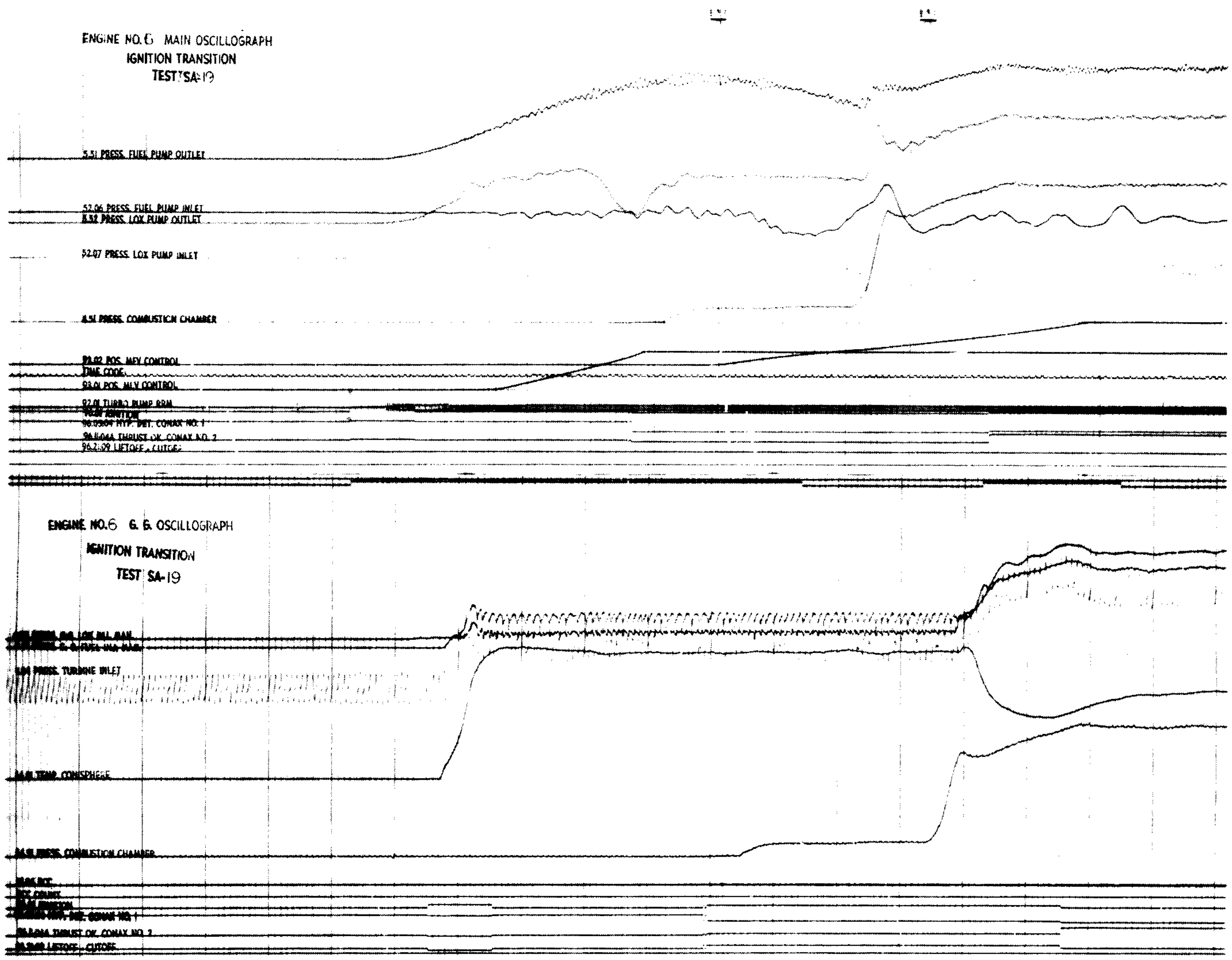
GRAPH 2-3


ENGINE NO. 5 G. G. OSCILLOGRAPH
IGNITION TRANSITION
TEST SA-19
TIME CODE
ENGINE NO. 5 MAIN OSCILLOGRAPH
IGNITION TRANSITION
TEST SA-19
5.51 PRESS. FUEL PUMP OUTLET
52.06 PRESS. FUEL PUMP INLET
52.07 PRESS. LOX PUMP INLET
93.02 POS. MFV CONTROL
93.01 POS. MLV CONTROL
92.01 TURBO PUMP RPM
96.21A THRUST OK. CONAX NO. 2
96.2100 LIFTOFF - CUTOFF

GRAPH 2-9


ENGINE NO.5 G.G. OSCILLOGRAPH
CUTOFF TRANSITION
TEST SA-19
TIME CODE
ENGINE NO.5 MAIN OSCILLOGRAPH
CUTOFF TRANSITION
TEST SA-19
5.51 PRESS. FUEL PUMP OUTLET
5.52 PRESS. LOX PUMP OUTLET
52.06 PRESS. FUEL PUMP INLET
8.51 PRESS. COMBUSTION CHAMBER
52.07 PRESS. LOX PUMP INLET
93.01 POS. MLV CONTROL

GRAPH 2-10


ENGINE NO.6 MAIN OSCILLOGRAPH
IGNITION TRANSITION
TEST SA-19
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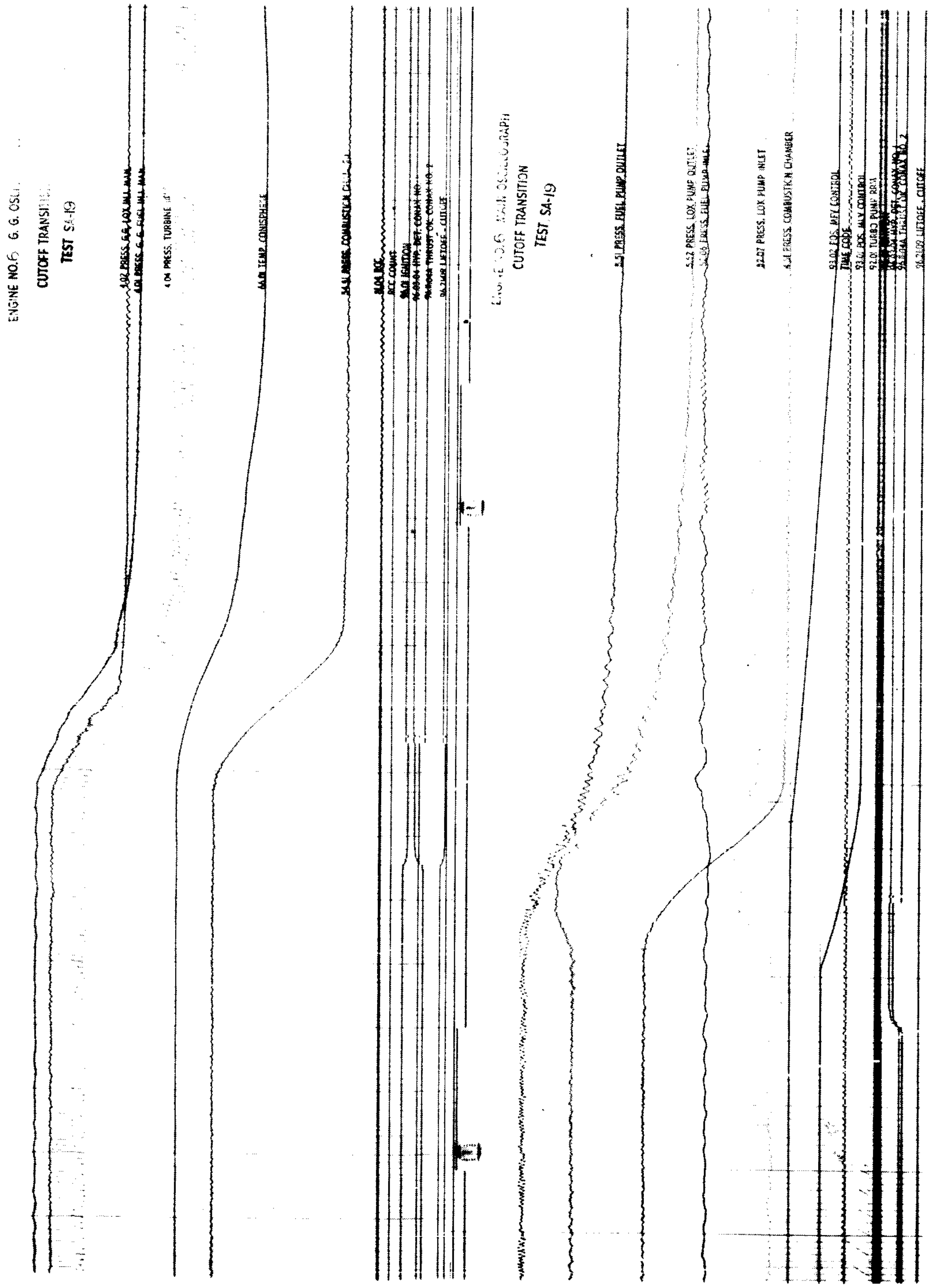
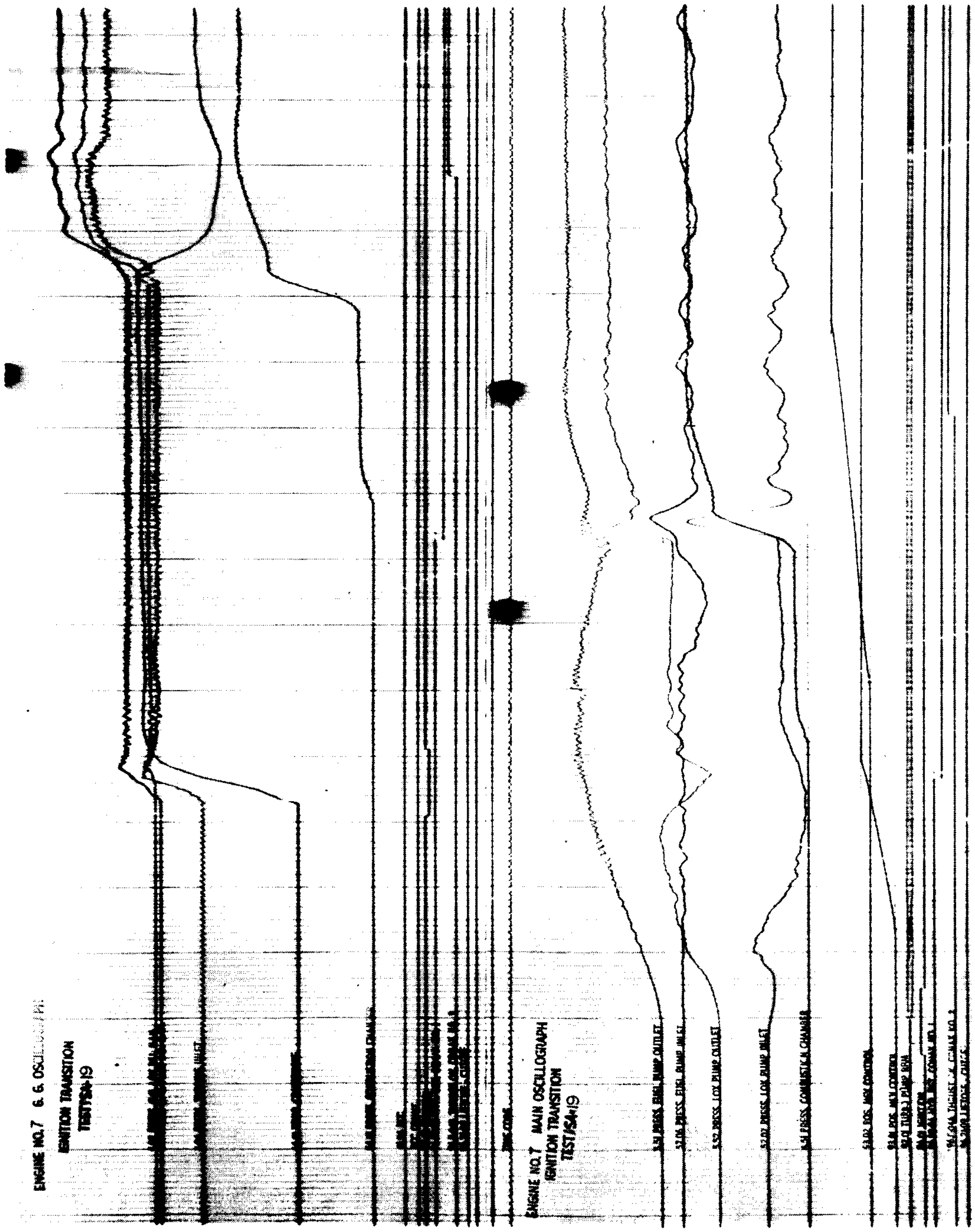
52.06 PRESS. FUEL PUMP INLET
52.07 PRESS. LOX PUMP INLET
ENGINE NO.6 G. G. OSCILLOGRAPH
IGNITION TRANSITION
TEST SA-19

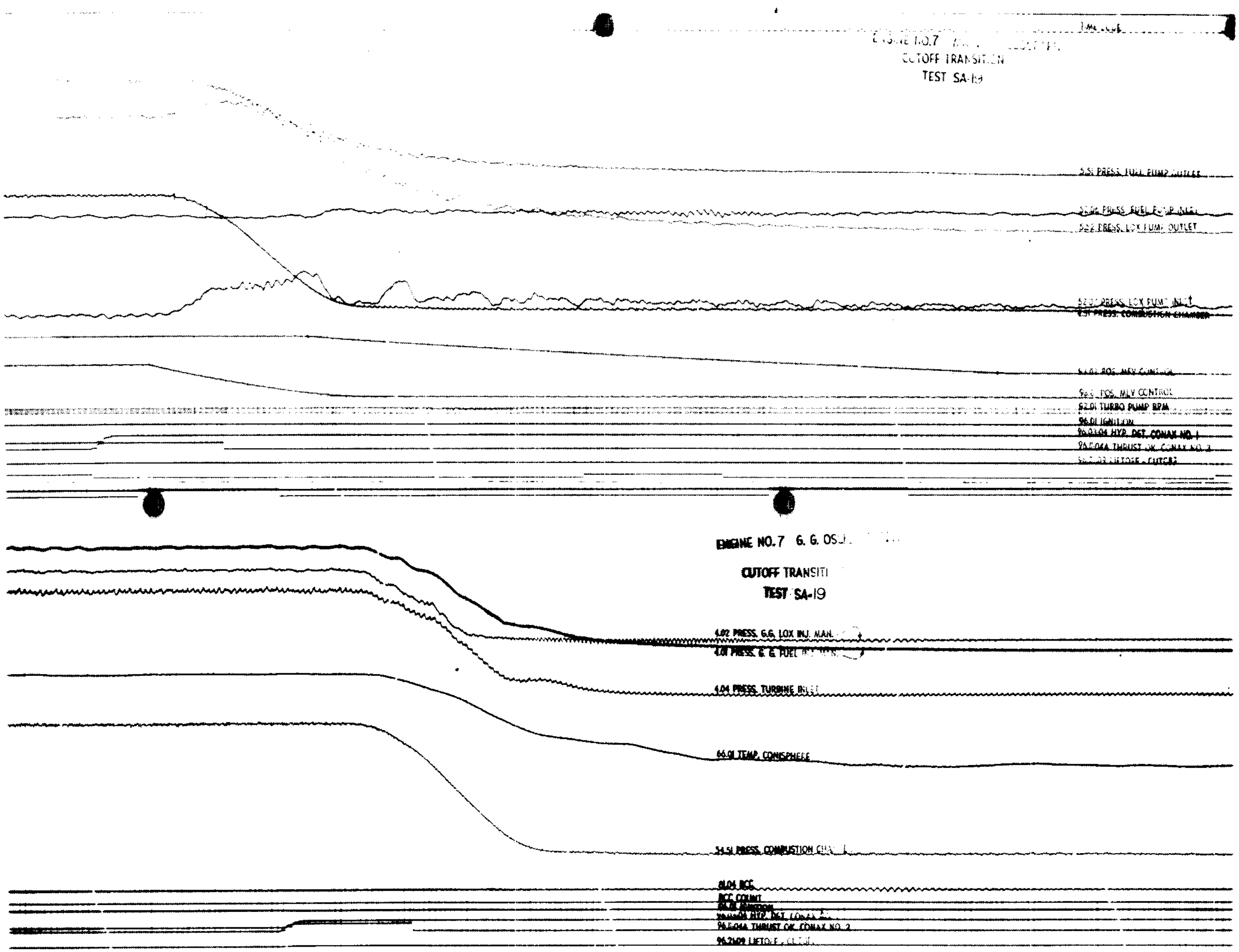
GRAPH 2-11


CUTOFF TRANSITION
TEST SA-19
CUTOFF TRANSITION
TEST SA-19
PRESS. FUEL PUMP OUTLET
PRESS. LOX PUMP INLET
TIME CODE

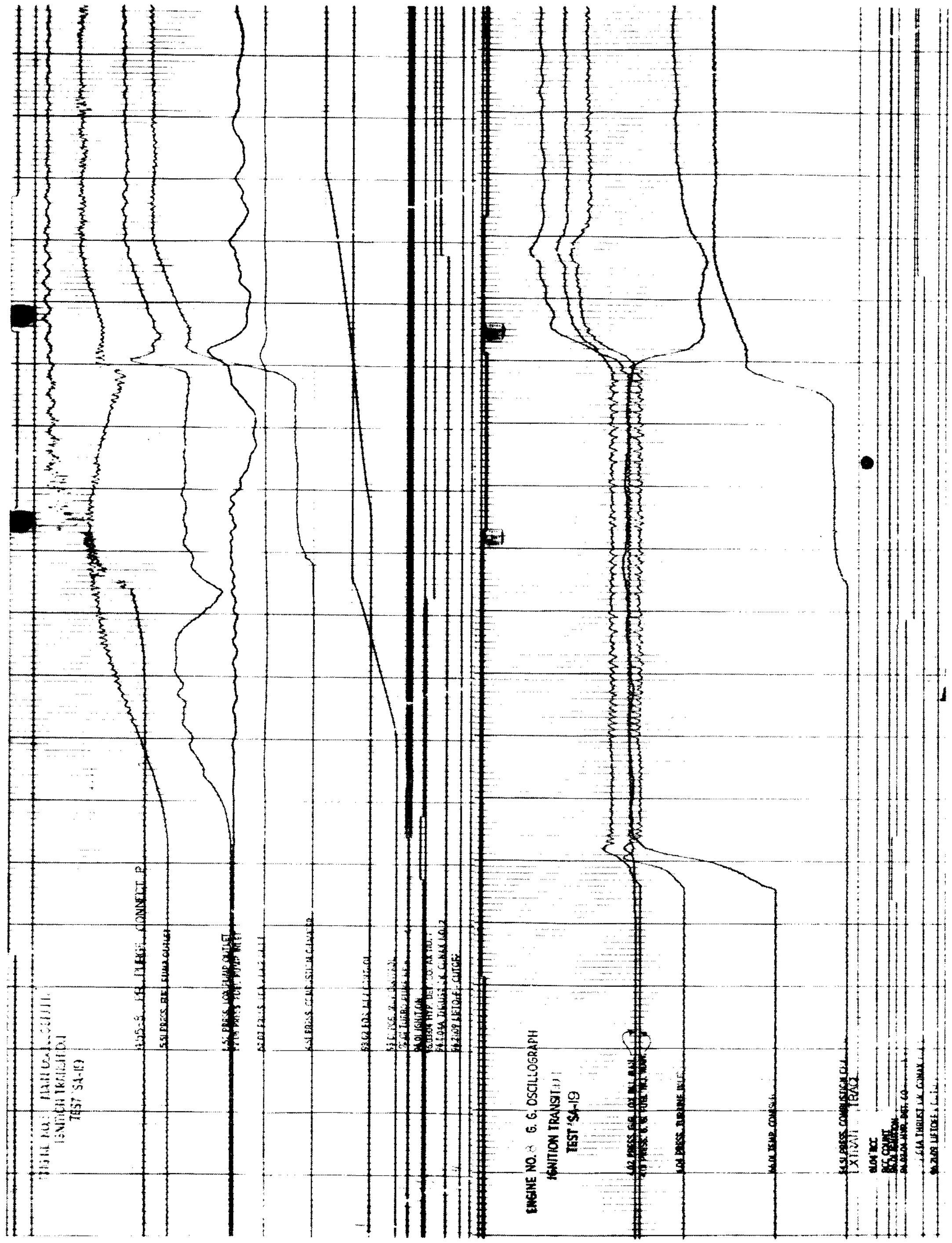
GRAPH 2-12



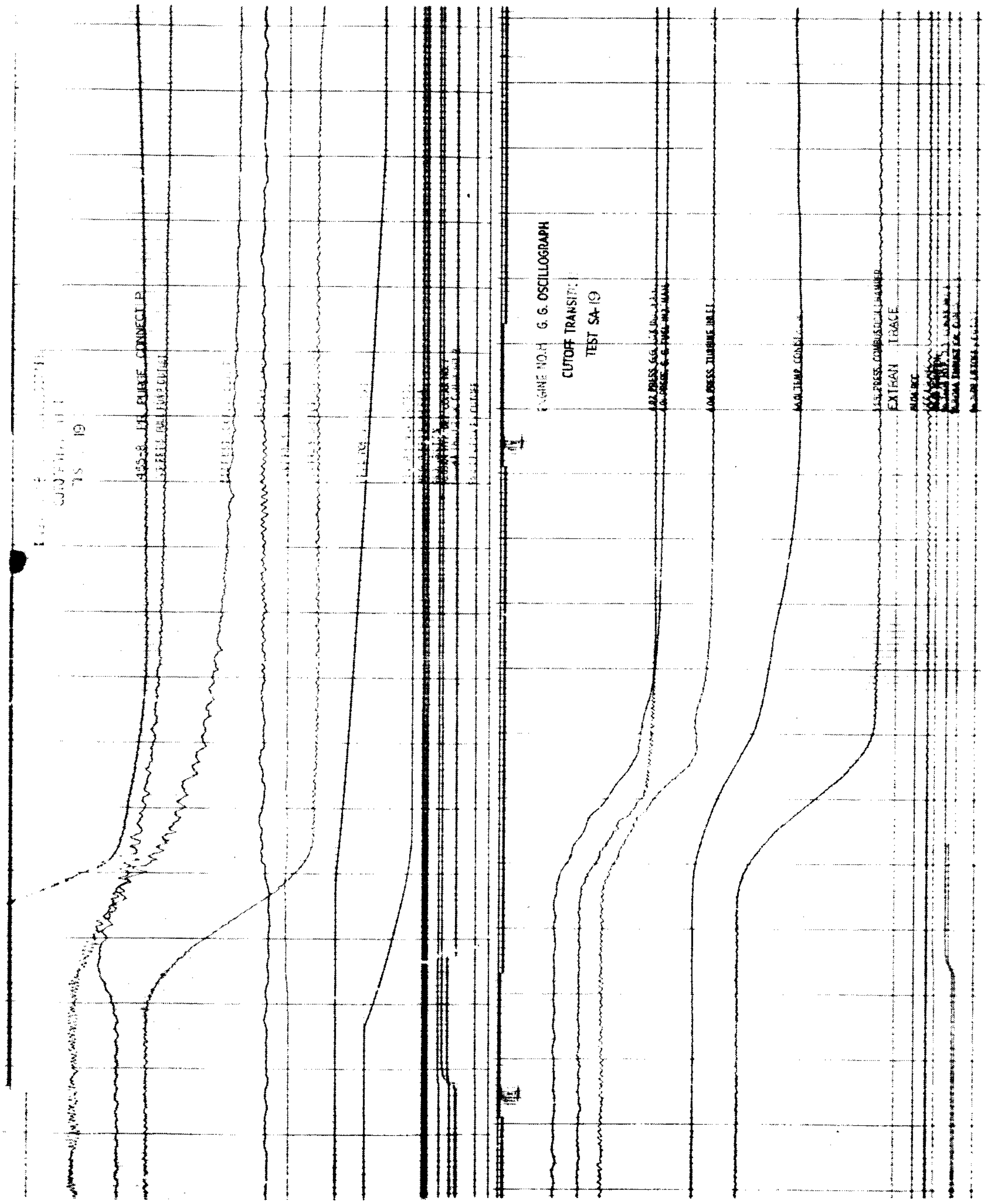
GRAPH 2-13


CUTOFF TRANSITION
TEST SA-19
5.51 PRESS. FUEL PUMP OUTLET
52.04 PRESS. FUEL PUMP INLET
5.52 PRESS. LOX PUMP OUTLET
52.03 PRESS. LOX PUMP INLET
6.51 PRESS. COMBUSTION CHAMBER
9.63 POS. MLV CONTROL
52.01 TURBO PUMP RPM
96.01 IGNITION
96.03.04 HYP. DET. CONAX NO. 1
96.F.04A THRUST OK. CONAX NO. 2
ENGINE NO. 7 6. G. OS
CUTOFF TRANSITI
TEST SA-19
6.02 PRESS. G.G. LOX INJ. MAN.
6.01 PRESS. G. G. FUEL
6.04 PRESS. TURBINE INLET
66.01 TEMP. CONISPHERE
54.51 PRESS. COMBUSTION
BCC COUNT
96.F.04A THRUST OK. CONAX NO. 2

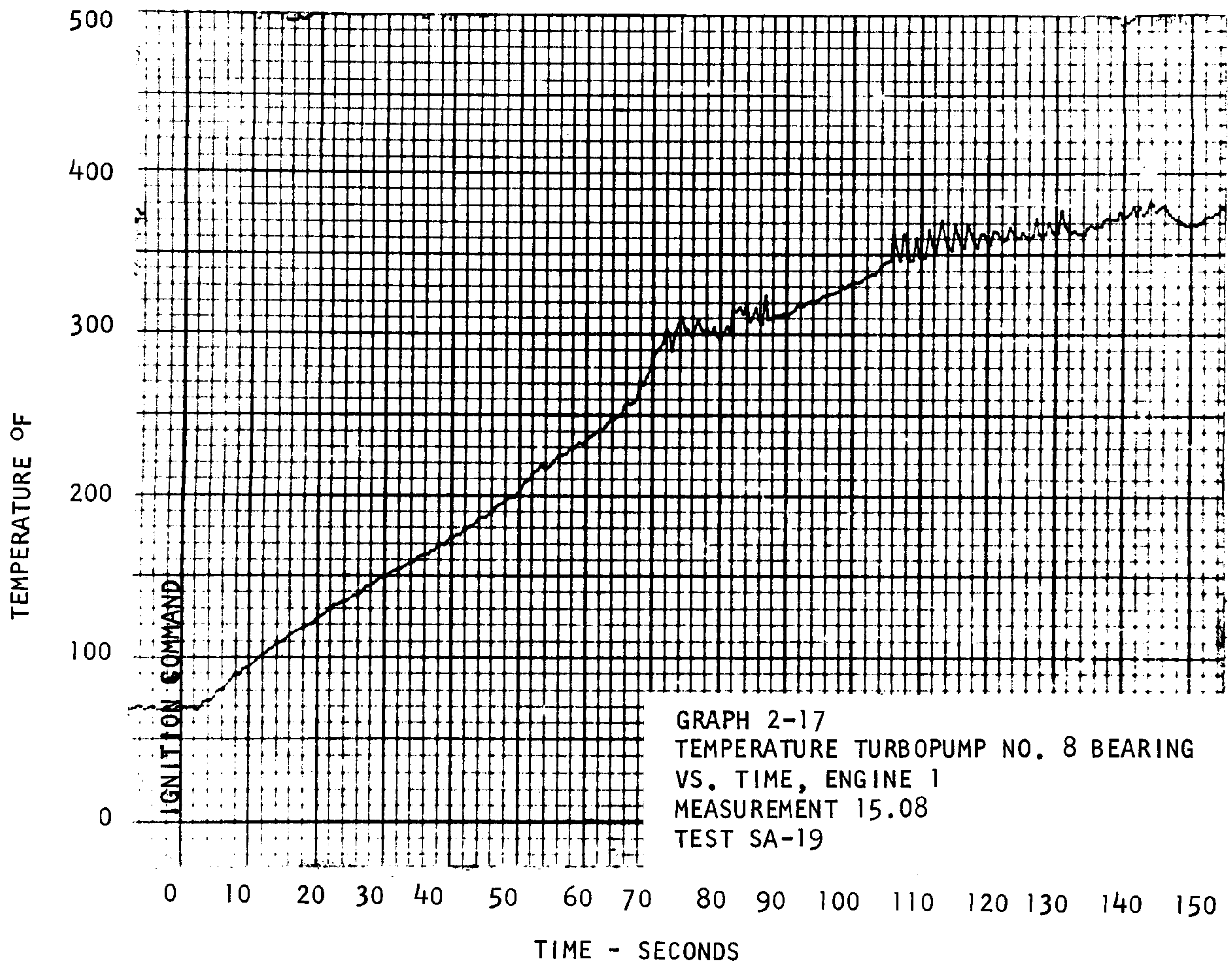
GRAPH 2-14



GRAPH 2-15



GRAPH 2-16



GRAPH 2-17
TEMPERATURE TURBOPUMP NO. 8 BEARING
VS. TIME, ENGINE 1
MEASUREMENT 15.08
TEST SA-19

SECTION 3
ENGINE HYDRAULIC SYSTEMS

The engine hydraulic systems operated satisfactorily during static test of stage S-I-9 with all engine hydraulic system static test requirements accomplished as outlined in the gimbal programs for each test. The gimbal programs for the two static tests are included in TABLES 3-1 and 3-2. No hydraulic leakage or system hardware damage was evidenced during the test series. A system schematic is shown in FIGURES 3-1 and 3-2.

Pretest SA-19 investigation of zero shifts which occurred on the differential pressure traces (measurements 55.62 and 55.63) during the X-15 minute countdown of test SA-18, revealed that these transducers had been incorrectly calibrated. Prior to test SA-19, measurement 55.62 and 55.63 transducers on engines 1, 2, and 4 were recalibrated.

A review of the SA-19 test records revealed a zero shift in the yaw actuator differential pressure trace (measurement 55.62) on engine 2 following ignition. Post-test investigation revealed that one of the transducer body connections was loose and that moisture was evident in the body connection. Unsatisfactory Condition Report 10662 was written recommending that this transducer be repaired or replaced when the stage returns to Manufacturing Engineering Laboratory.

Erratic fluctuations were indicated by the supply pressure trace (measurement 56.01) on engine 3 during test SA-19. A similar condition also existed at engine 1 on stage S-I-7 during test SA-16. In this instance, the transducer was replaced and normal results were obtained during test SA-17. Because of this similarity of these conditions and since these fluctuations were not reflected in other parameters, a faulty supply pressure transducer for measurement 56.01 is suspected on stage S-I-9. Unsatisfactory Condition Report 10661 was written recommending that this condition be investigated further when stage S-I-9 returns to Manufacturing Engineering Laboratory.

For further details pertaining to the operation of the engine hydraulic system, refer to the tables and graphs contained in the Preliminary Static Test Reports for tests SA-18 and SA-19.

ENGINE HYDRAULIC SYSTEM SCHEMATIC

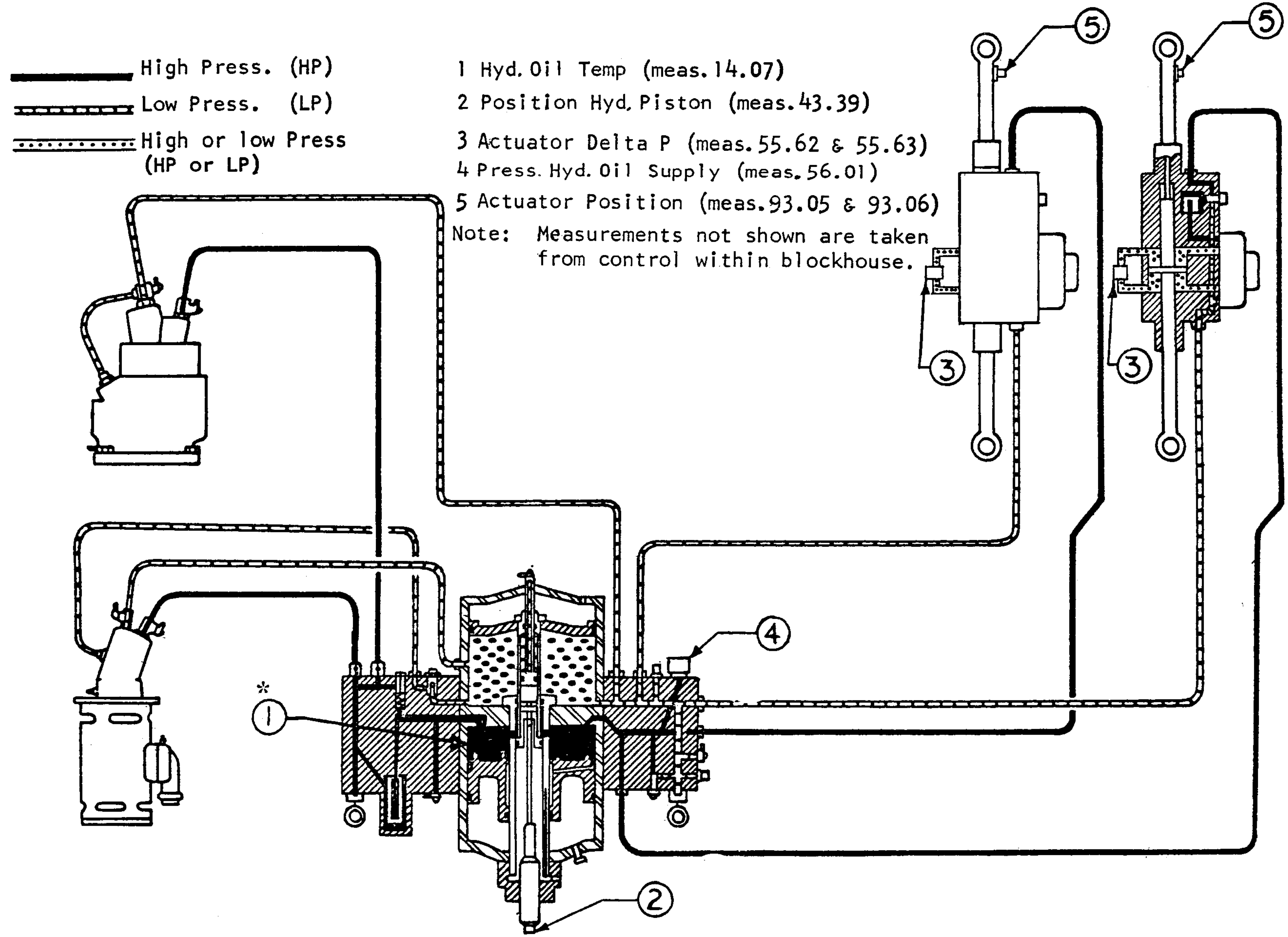


FIGURE 3-1 * Probe extends into cavity shown.

ENGINE HYDRAULIC SYSTEM, PICTORIAL SCHEMATIC

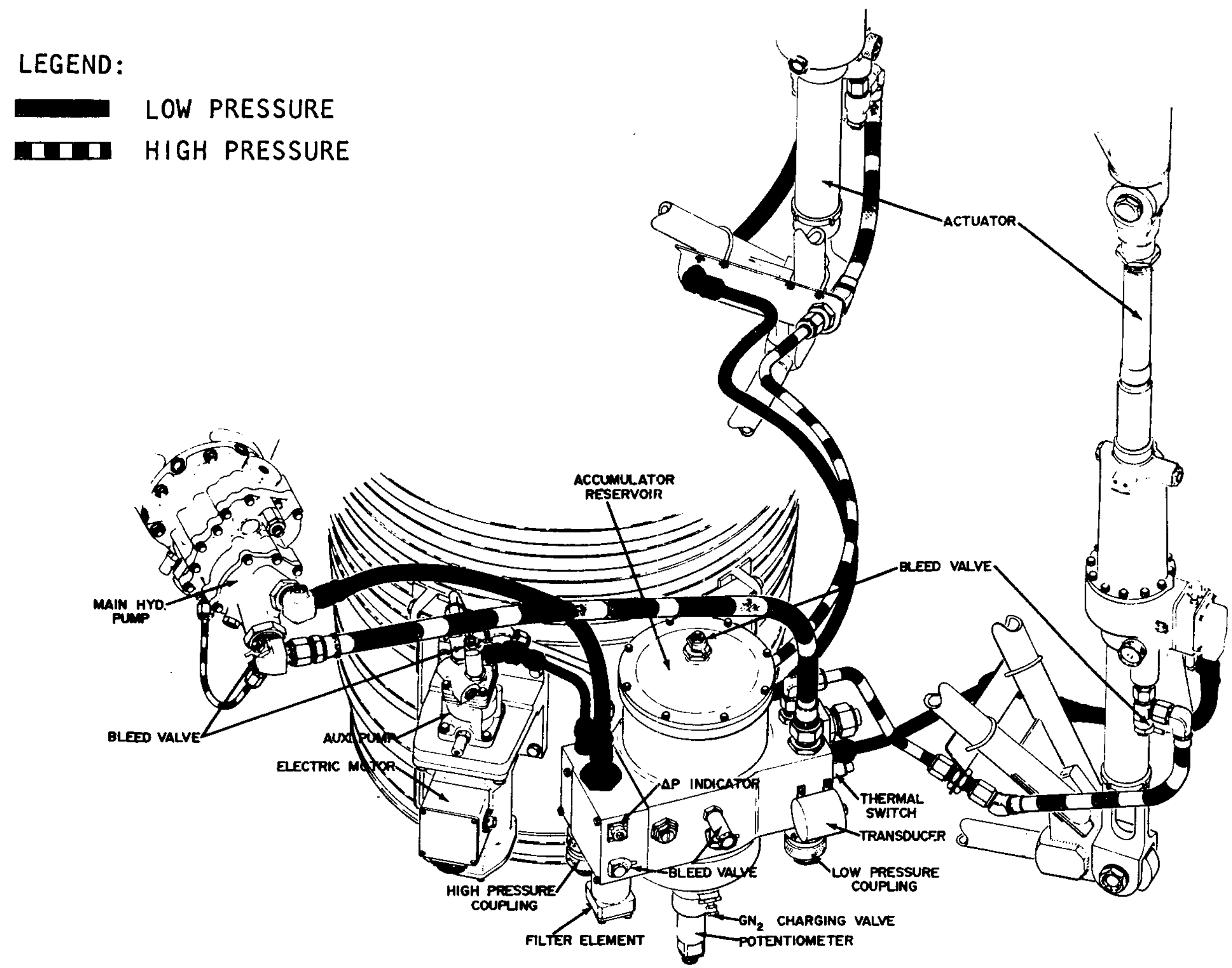


FIGURE 3-2

TABLE 3-1
GIMBAL PROGRAM, TEST SA-18

ENGINES	TIME (SECONDS)	FREQUENCY (cps)	INPUT (degrees)
1, 2, 3, & 4	X+3-5.5	2	±2 Roll All
1, 2, 3, & 4	X+7-12	1	±3 Yaw All
1, 2, 3, & 4	X+14-19	1	±3 Pitch All
1, 2, 3, & 4	X+21-22	+ STEP	2 Yaw All
1, 2, 3, & 4	X+23-24	- STEP	2 Yaw All
1, 2, 3, & 4	X+25-26	+ STEP	2 Pitch All
1, 2, 3, & 4	X+27-28	- STEP	2 Pitch All

TABLE 3-2
GIMBAL PROGRAM, TEST SA-19

ENGINE	X-TIME (sec.)	FUNCTION	DEGREES ON ACTUATOR	FREQUENCY (cps)
1,2,3, & 4	0 - 5	-	0	0
1,2,3, & 4	5 - 35	Pitch	$\pm\frac{1}{2}^{\circ}$	1 Thru 20
1,2,3, & 4	35 - 40	-	0	0
1,2,3, & 4	40 - 70	Yaw	$\pm\frac{1}{2}^{\circ}$	1 Thru 20
1,2,3, & 4	70 - 75	-	0	0
1,2,3, & 4	75 - 76	Pitch	+2	Step
1,2,3, & 4	76 - 80	-	0	0
1,2,3, & 4	80 - 81	Pitch	-2	Step
1,2,3, & 4	81 - 85	-	0	0
1,2,3, & 4	85 - 86	Yaw	+2	Step
1,2,3, & 4	86 - 90	-	0	0
1,2,3, & 4	90 - 91	Yaw	-2	Step
1,2,3, & 4	91 - 100	-	0	0
1,2,3, & 4	100 - 130	Pitch & Yaw	$\pm 2.1^{\circ}$	$\frac{1}{2}$
1,2,3, & 4	130 - Cutoff	-	0	0

SECTION 4
PROPELLANT AND PNEUMATIC SYSTEMS

PROPELLANT LOADING, SUBSYSTEMS TESTS, AND SPECIAL PROPELLANT TESTS. The propellant loading and subsystems tests were performed on March 2 and March 3, 1964. The system configuration (i.e., purge settings, pressure switch settings, orifice sizes, etc.) is defined in APPENDIX E, Test Data Sheet, Tests SA-18 and SA-19. The primary test objectives were as follows:

1. Prefiring leak check of propellant system.

2. Prefiring checkout of countdown and automatic firing sequence with pressurization, bubbling, purge operation, 35 second simulated firing, and firing panel cutoff included.

3. To check propellant system for contamination by pump inlet screen inspection after completion of the loading test.

4. To determine prevalve actuation times under LOX conditions and to reorifice the prevalves as required.

5. To check out continuous level probes, propellant level discrete probes, and propellant low level and depletion probes.

Additional special propellant tests were conducted on March 3, 1964. These test objectives were as follows:

1. To record fuel temperature at 15 minute intervals commencing at the start of LOX loading and continuing for 3 hours (reference Memo R-P&VE-PT 179-63).

2. To record umbilical compartment ambient air temperature at 15 minute intervals commencing at the start of LOX loading and continuing for 3 hours after completion of final leak check (reference Memo R-P&VE-PT 179-63).

3. To measure residual LOX upon LOX drain (reference Memo R-P&VE-PT 121-63).

4. To measure LOX prevalve relief pressure.

On March 2, 1964, fuel was loaded to 41,630 gallons. Fuel was tanked through the fill and drain valves on fuel tanks 1 and 2. Leak check was conducted and a fuel leak was found on engine 7. This leak was repaired and no other leakage was observed.

On March 3, 1964, LOX was initially loaded to 65,680 gallons. To compensate for boiloff, LOX was topped to 64,680 gallons at X-1 hour. Leak check was conducted and no leaks were found. The propellant loading test was performed in accordance with Chrysler procedure 6-CH SI-609 which includes leak check, verification of cleanliness, check of prevalve closing times, and the verification of the operation of pneumatic and networks systems during a simulated countdown. The test was successful. The prevalve closing times are discussed further in this section. The results of the special test objectives were reported in Chrysler Corporation Space Division memorandum, File No. T-244, entitled, "S-I-9 Propellant Loading and Sub-Systems Test Program Special Tests."

On March 4, 1964, the LOX and fuel pump inlet stainless steel screens were removed from all engine suction lines for inspection. There was no excessive foreign matter found on the pump inlet screens. The discrepancies that were observed during the propellant loading and subsystems tests were corrected prior to test SA-18.

<u>LOX SYSTEM</u>. The LOX system functioned satisfactorily during tests SA-18 and SA-19. A system schematic is shown in FIGURES 4-1 and 4-2. LOX tank ullage at test SA-18 ignition was 594 cubic feet (4465 gallons) or 6.53 percent; preignition pressurization of the system was accomplished in 73 seconds: The LOX tank ullage at test SA-19 ignition was 926 cubic feet (6930 gallons) or 10.2 percent. To provide sufficient time for LOX tank preignition pressurization, a 22 second ignition hold was initiated at X-40 seconds. Preignition pressurization for test SA-19 was accomplished in 99.5 seconds. Further details pertinent to propellant loading and pressurization may be found in TABLE 4-1.

LOX tank pressure exceeded the specified limits of 50±2.5 psia. During test SA-18, the LOX tank pressure attained a maximum of 54 psia at X+25 seconds. Following ignition on test SA-19, LOX tank pressure fluctuated slightly and stabilized at 54 psia at X+5 seconds. This pressure was maintained until X+33 seconds, after which time it slowly decreased to 52 psia at X+63 seconds and was 49.7 psia at outboard engine cutoff signal. A plot of center LOX tank pressure (measurement 2.05-C) versus time for tests SA-18 and SA-19 is shown in GRAPH 4-1.

It was not possible to accurately determine the performance of the GOX Flow Control Valve (GFCV) during test SA-18 because of the loss of the position indicator measurement, 43.49A. However, the differential pressure across the GFCV bellows (measurement 3.61) indicated that there was sufficient pressure to close the GFCV.

The GFCV functioned properly during test SA-19. A plot of the GFCV gate position versus time is shown in GRAPH 4-2. GOX pressure recorded at the inlet to the GFCV was substantially higher (170 psi higher at inboard cutoff signal) during this test than has been recorded during the previous two full duration tests. Because of this higher inlet pressure, an adequate pressure supply was provided to the GFCV bias regulator, and a constant control pressure of 300±5 psig was maintained throughout the test. As a result, the constant control pressure eliminated the cycling characteristics exhibited by the GFCV during the previous four full duration tests.

The 1.5 psi over-pressurization of the LOX system was due to excessive GOX flow past the closed GFCV gate. The excessive GOX flow was possibly due to incorrect GFCV stop set points, improper LOX-to-heat exchanger orifice sizes, excessive output of the heat exchangers, or a combination of these.

To simulate flight LOX depletion characteristics during static test, a 20.5 inch diameter orifice was installed in the center LOX tank sump prior to test SA-19 (reference Memo R-P&VE-PT-121-63). This orifice replaced the 17.0 inch flight orifice and was designed to retain the LOX level in tank O-C 6 inches higher than the LOX level in the outer LOX tanks at inboard engine cutoff signal. Evaluation of the LOX discrete and continuous level probe data indicates that the specified height differential was not attained (see TABLES 4-2, 4-3, and 4-4). At inboard engine cutoff signal, the LOX discrete probes indicated the LOX level in tanks O-2 and O-4 was approximately 3 inches higher than the LOX level in tank O-C. The continuous level probes also indicated approximately the same LOX level difference between tank O-2 and tank O-C. Stage S-I-8 will incorporate a 20.0 inch orifice for the static test firings.

As mentioned previously in the ENGINE SYSTEMS section, inboard engine cutoff signal for test SA-19 was initiated by the flight sequencer two seconds after closure of the LOX low level sensor in tank O-4. LOX depletion cutoff of the outboard engines was initiated 3.77 seconds later when the Thrust OK pressure switch on engine 4 dropped out. The 3.77 second interval between inboard and outboard cutoff was less than the anticipated interval (approximately 6 seconds) and becomes critical for payloads such as the micrometeoroid satellites. The primary cause for this short time interval has been attributed to a combination of two factors:

1. The LOX low level sensor probe was located to accommodate a 12 inch height differential rather than the 6 inch height differential required on stage S-I-9 (the probe for a 12 inch height differential is situated lower in the LOX tank than for a 6 inch height differential and would cause inboard engine cutoff to be initiated later).

2. The 20.5 inch diameter center LOX tank liquid orifice did not yield the calculated 6 inch height differential.

Further opportunity to check the cutoff transition will be provided with stage S-I-8, which will be static test fired with properly located probes in conjunction with the resized center LOX tank liquid orifice.

PREVALVE RELIEF TEST. To evaluate the relief capabilities of the reworked prevalves, a special test was initiated immediately following test SA-18 cutoff. The prevalves closed at cutoff and were left in the closed position for 15 minutes. During this period, the pressures in the LOX suction lines were monitored. Data obtained from this test are presented in GRAPHS 4-3 through 4-10. Maximum pump inlet pressure recorded was 41.3 psig in the LOX suction line to engine 2. The spike indicated in each of the LOX pump inlet pressure traces is caused by closing of the prevalves at cutoff and is normal.

PREVALVE CLOSING TESTS. It is standard practice to check prevalve closing times prior to the first static test firing to assure that the LOX prevalves close before fuel prevalves at cutoff. This is required, since the prevalves serve as an emergency engine shutdown device and, in this event, LOX must be isolated from the engine first to preclude damage which would result from an oxidizer-rich cutoff.

Stage S-I-9 was received with orifices installed in the LOX and fuel prevalve control lines. Simulated flight test prevalve closing times were obtained with the orifices installed and at ambient temperature (see TABLE 4-5). The average signal-to-switch closing times was 0.72 seconds for LOX prevalves and 1.75 seconds for fuel prevalves.

Propellant Loading Test prevalve closing times were obtained with orifices installed and 3 hours exposure to cryogenic temperatures (see TABLE 4-6). The average signal-to-switch closing times were 1.52 seconds for LOX prevalves and 1.70 seconds for fuel prevalves. Fuel prevalves No. 1, 2, and 4 indicated closure prior to the LOX prevalves. Because of these times, the orifices in the LOX prevalve control lines were removed. The removal of these orifices has also been required on stages S-I-5, S-I-6, and S-I-7.

Sequence Test prevalve closing times were obtained at ambient temperatures after LOX prevalve orifices were removed (see TABLE 4-7). The average signal-to-switch closing times were 0.62 seconds for LOX prevalves and 1.74 seconds for fuel prevalves.

Prevalve closing times were established following a 100 inch LOX leak check conducted on March 18, 1964. The LOX prevalve orifices were removed and the closing times were obtained after 1 hour exposure to cryogenic temperatures (see TABLE 4-8). The average closing times were 0.60 seconds for LOX prevalves and 1.65 seconds for fuel prevalves. The engine 5 LOX prevalve was replaced prior to test SA-18 because of erratic closure indications.

Test SA-18 prevalve closing times were obtained with the LOX prevalve orifices removed and after four hours exposure to cryogenic temperatures (see TABLE 4-9). The average closing times were 0.84 seconds for LOX prevalves and 1.71 seconds for fuel prevalves.

Test SA-19 prevalve closing times were obtained with LOX prevalve orifices removed and 7 hours exposure to cryogenic temperatures (see TABLE 4-10). The average closing times were 1.52 seconds for LOX prevalves and 1.62 seconds for fuel prevalves. The engine 8 fuel prevalve indicated that it closed prior to the LOX prevalve.

The prevalve closing time differences as recorded during tests SA-18 and SA-19 indicate that extended exposure to cryogenic temperatures affect the prevalve closing times.

Since it has been necessary to remove the LOX prevalve control line orifices on previous stages to improve LOX prevalve closing times, it is recommended that subsequent stages be delivered to STTE with the LOX prevalve orifices removed. Inasmuch as it is not known whether the LOX prevalves are closing slower at cryogenic temperatures or whether the valve position indicator is not giving a true valve position indication, it is also recommended that more extensive acceptance and qualification tests be performed and corrective action taken. Additional investigative tests are scheduled to be conducted on stage S-I-8.

FUEL SYSTEM. The fuel system functioned satisfactorily during the acceptance test firings. The system configuration for the test is shown in FIGURE 4-3.

During tests SA-18 and SA-19, the system was pre-pressurized to 16.8 psig in 4 seconds and 3.33 seconds, respectively. System pressurization from the stage spheres was normal. During test SA-19, pressurization was terminated at X+71 seconds by the flight sequencer after which time the fuel tank pressure was supplied by the auxiliary ground source. GRAPH 4-11 shows a plot of the fuel system pressurization versus time for the full duration test, SA-19. Also shown on this graph is the pressure versus time history for the fuel tank pressurization spheres.

The post-test evaluation of the discrete and continuous probe data indicated some variance in the fuel depletion rates of each individual tank (see TABLES 4-2, 4-3, and 4-4). This differential was not extreme and was not detrimental to stage performance during static test.

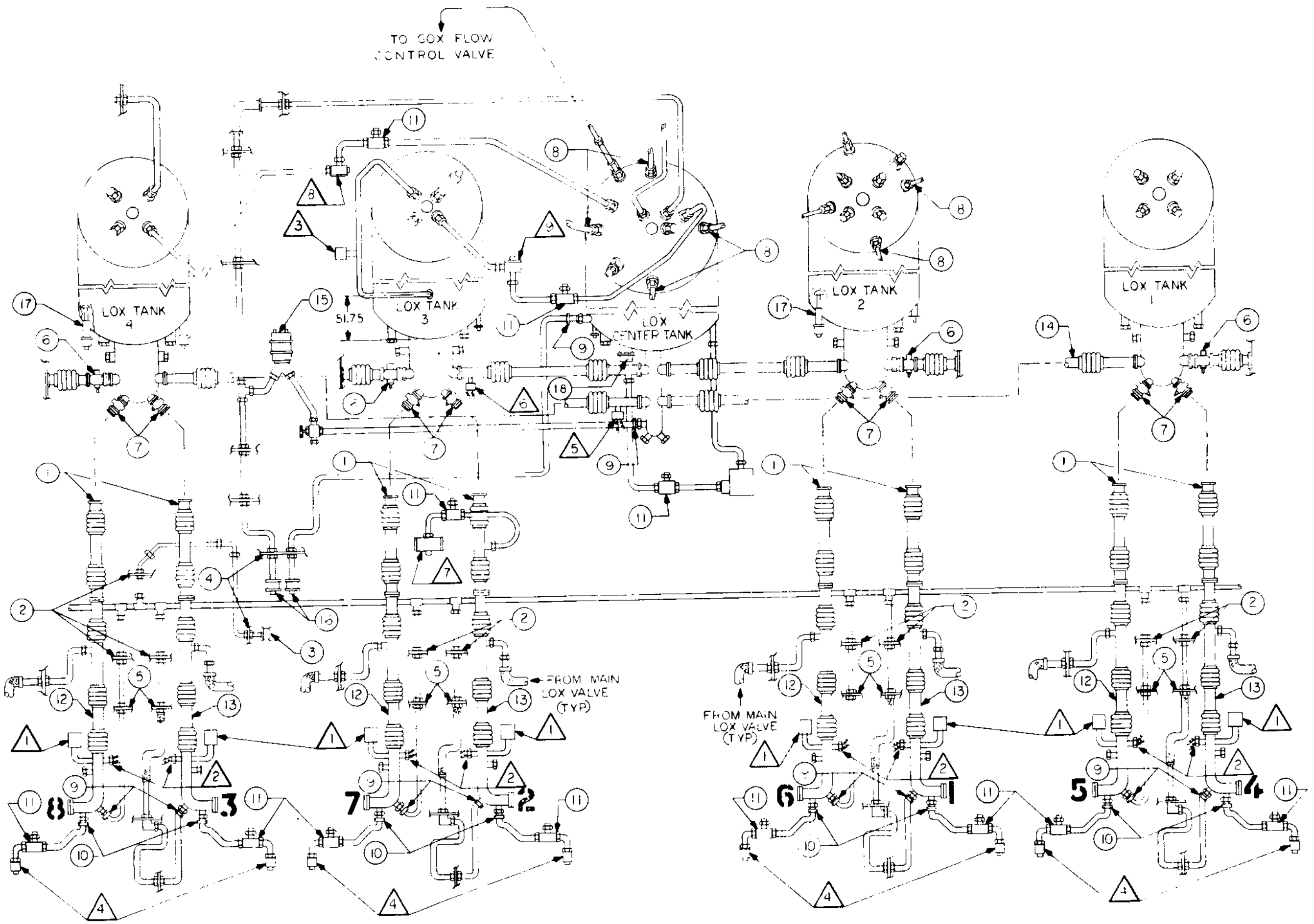
LOX-SOX DISPOSAL SYSTEM. The LOX-SOX disposal system functioned properly during test SA-19 (see GRAPHS 4-12 and 4-13). The system was not activated during test SA-18. The disposal ring manifolds were not included as a part of the test configuration, and the flow rate from the system was controlled with 0.875 inch diameter orifices located in each of the plenum chamber outlets. The complete LOX-SOX system configuration is shown in FIGURE 4-4.

CONTROL PRESSURE SYSTEM. The control pressure system functioned satisfactorily during tests SA-18 and SA-19.

The control pressure system stores nitrogen gas under pressure and supplies it on demand to several electro-pneumatic control valves. These valves, upon receipt of a command signal, open or close to permit control pressure to actuate various pneumatic-mechanical valves in the fuel and LOX systems. This system also supplies GN_2 for calorimeter purging, and for engine turbopump gearbox pressurization and LOX seal purging. A schematic of the control pressure system is shown in FIGURE 4-5.

During a full duration test firing, the control spheres pressure (measurement 6.06) normally decays from the initial 3000 psig to approximately 2200 to 2300 psig at outboard engine cutoff signal. However, during test SA-19, the control spheres pressure decayed to 1600 psig at outboard engine cutoff signal (see GRAPH 4-14). There were leaks in the system, but these were of such a minor nature that this leakage could not account for the excessive pressure decay rate. In addition, the system was purging only four calorimeters for static test instead of the 10 calorimeters required for flight, which would lessen the demand on the system. At the present time, it is not known what caused the excessive control spheres pressure decay rate.

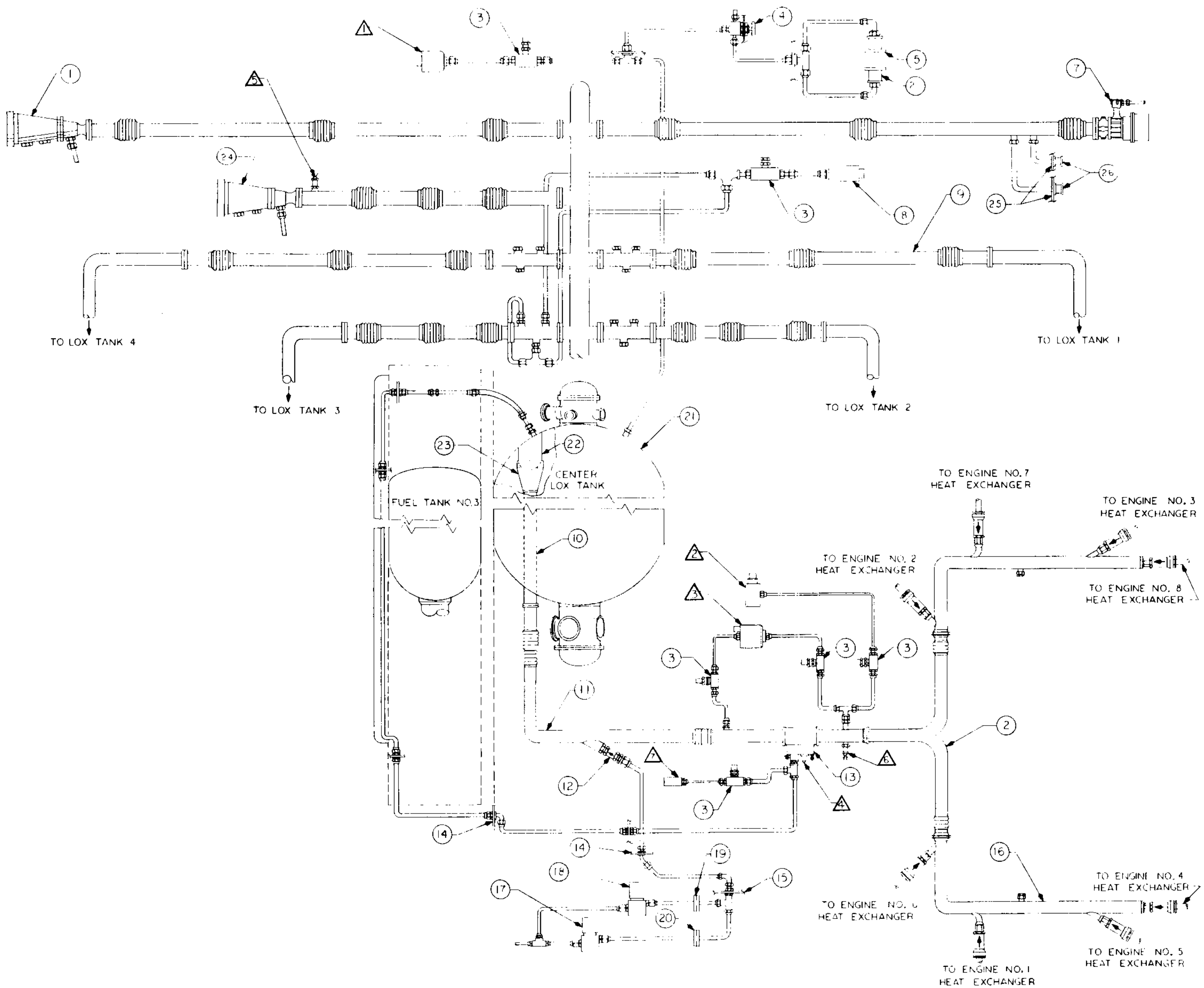
Control pressure tubing assembly (P/N 10M10003) was broken at the "B"-nut connection to engine 8 fuel prevalve (reference UCR 10666). The prevalve had been leak checked during the control system leak check following test SA-19 and prior to discovery of the defect, and no leakage was found. Repairs will be effected while the stage is located at Manufacturing Engineering Laboratory.



FIND NO	ITEM
1	LOX SUCTION LINE (TYP 8 PLCS)
2	CENTER BARREL WALL (TYP 9 PLCS)
3	LOX BUBBLING SUPPLY
4	LOWER UMBILICAL FIN IV
5	FIREWALL (TYP 8 PLCS)
6	LOX FILL & DRAIN VALVE (TYP 4 PLCS)
7	LOX PREVALVE (TYP 8 PLCS)
8	ΔP SLOSH MEASURING TUBE
9	LOX BUBBLING ORIFICE
10	MEASUREMENT ORIFICE
11	CALIBRATION VALVE
12	WRAPAROUND LINE - INBD (TYP 4 PLCS)
13	WRAPAROUND LINE - OUTB (TYP 4 PLCS)
14	INTERCONNECT LINE
15	ΔSTEP PRESS. SWITCH
16	LOX SENSING
17	CUT OFF SENSOR (TYP 2 PLCS)
18	GOX LINE

1	MEAS. NO. 52.07 PRESS. LOX PUMP INLET (TYP 8 PLCS)
2	MEAS. NO. 19.01 TEMP LOX PUMP INLET (TYP 8 PLCS)
3	MEAS. NO. 2.17 LOX ΔP PRESS. TRANSDUCER
4	MEAS. NO. 2.07 (TYP 8 PLCS) LOX PUMP INLET PRESS. TRANSDUCER
5	MEAS. NO. 19.44-C TEMP-LOX DEPLETION INDICATOR
6	MEAS. NO. 19.44-3 TEMP-LOX DEPLETION INDICATOR
7	MEAS. NO. D113-9 PRESS. LOX SUCT.
8	MEAS. NO. D118-10 DIFFERENTIAL PRESS.
9	MEAS. NO. D117-10 DIFFERENTIAL PRESS.

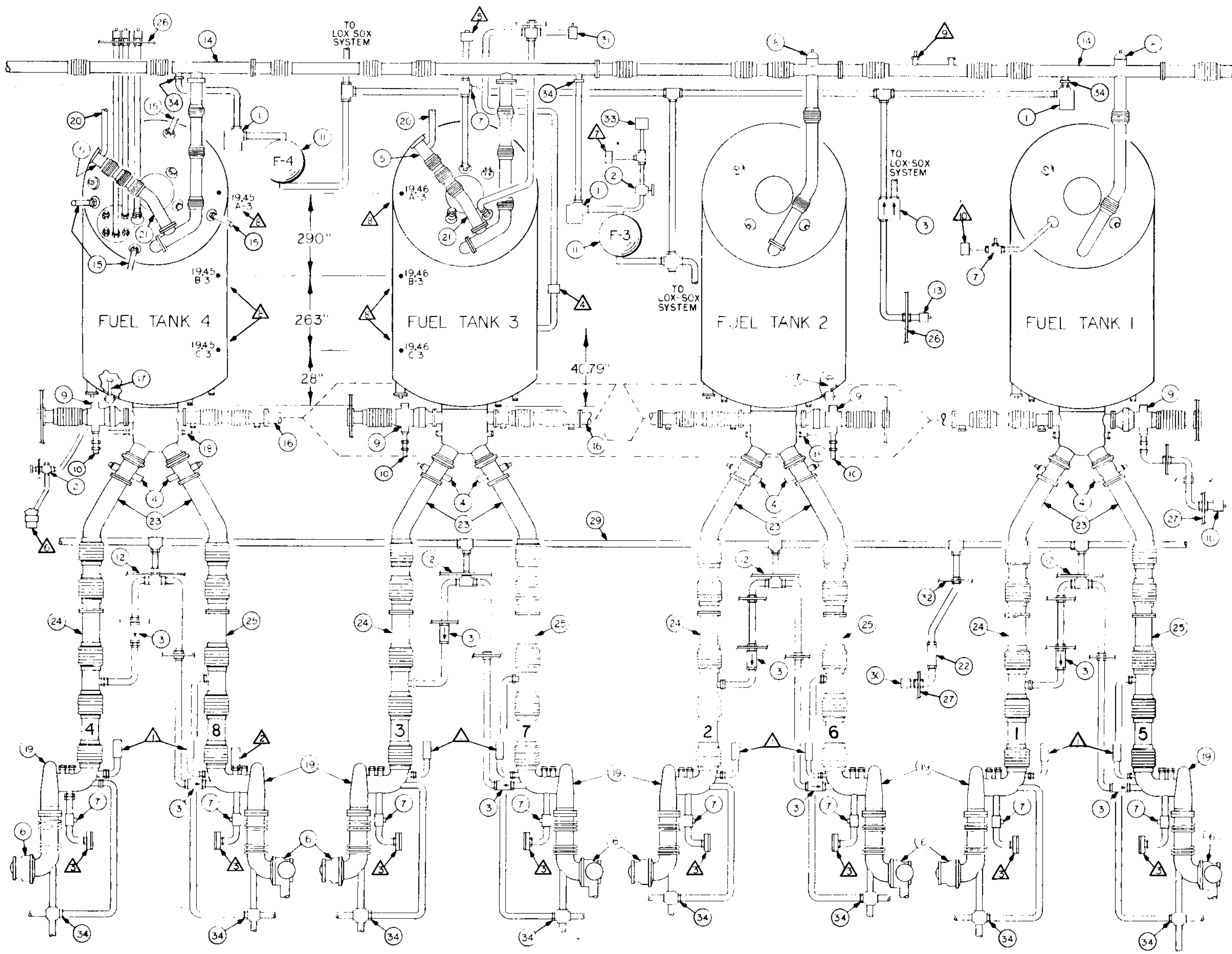
FIGURE 4-1 LOX TANKS SUPPLY SYSTEM



FIND NO.	ITEM
1	LOX RELIEF VALVE 2
2	[illegible] TOP
3	CALIBRATION VALVE (TYPICAL 6 PLACES)
4	HAND VALVE (3 WAY)
5	LOX TANK [illegible]ZED & PRESS. RELIEF SW.
6	[illegible] TANK [illegible] PRESS SW
7	[illegible] INCH LOX VENT VALVE
8	PRESSURE TRANSDUCER
9	GOX INTERCONNECT (TYPICAL)
10	GOX STANDPIPE
11	LOX TANK PRESSURE LINE
12	CHECK VALVE
13	GOX FLOW CONTROL VALVE
14	CENTER BARREL (2 PLACES)
15	LOWER UMBILICAL FIN II
16	GOX MANIFOLD
17	GROUND LOX PRESSURIZING SOLENOID VALVE
18	ORIFICE BYPASS PRESSURIZING SOLENOID VALVE
19	.31 DIAMETER ORIFICE
20	.149 DIAMETER ORIFICE
21	CENTER TANK BULKHEAD
22	GOX DIFFUSER SCREEN
23	STANDPIPE FUNNEL
24	LOX RELIEF VALVE 1
25	TANK OH BULKHEAD
26	FACILITY LOX TANK PRESSURIZING

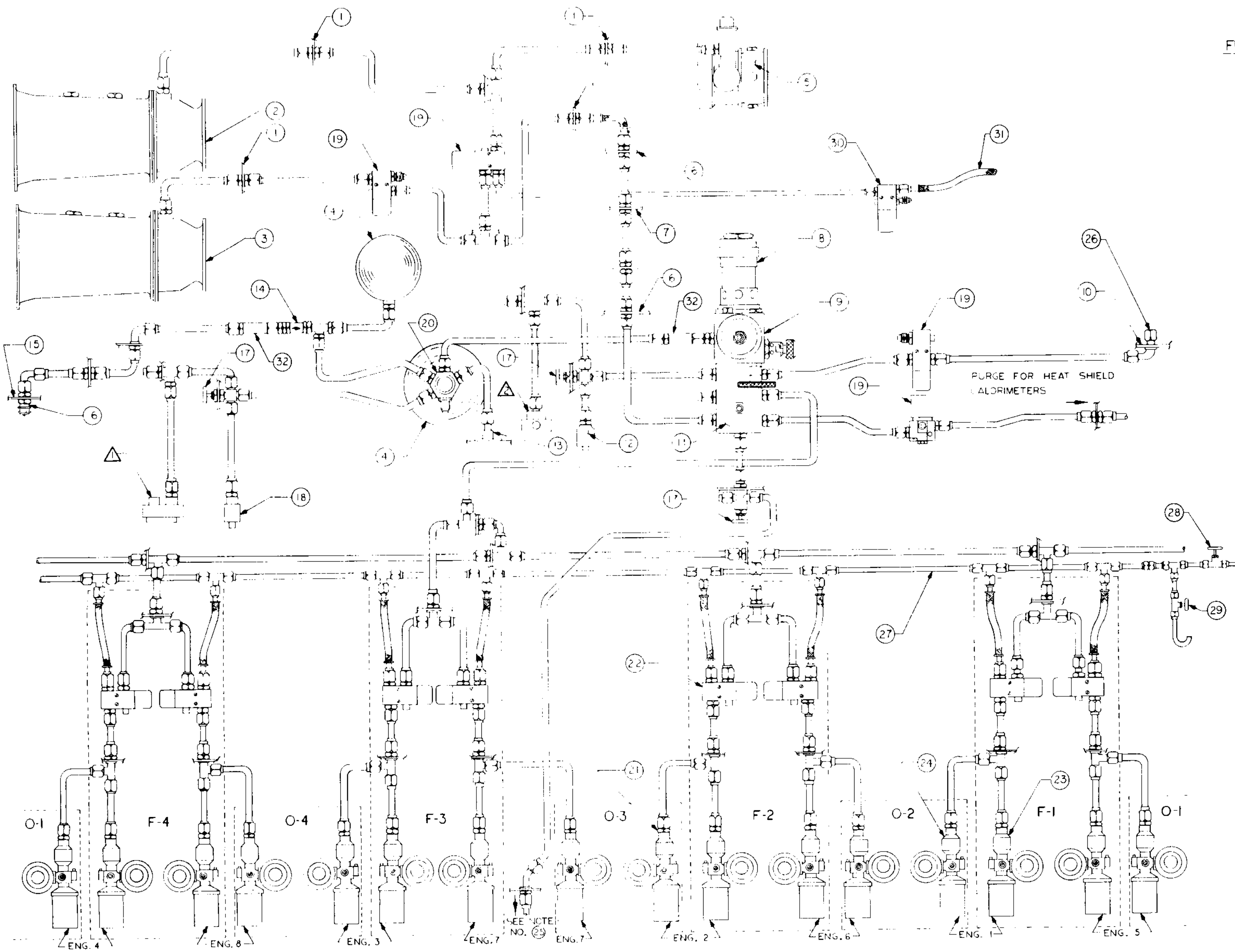
1	MEASUREMENT 2.05 C LOX TANK PRESSURE
2	D119-9 PRESSURE INLET GOX FLOW CONTROL VALVE PRESSURE TRANSDUCER
3	D114-9 ΔP ACROSS GOX FLOW CONTROL VALVE PRESSURE TRANSDUCER
4	MEASUREMENT 43.4-A POSITION GOX FLOW CONTROL VALVE
5	TEMPERATURE GAGE (C 188 11)
6	MEASUREMENT C 234-9 TEMP GOX VALVE INLET
7	MEASUREMENT D112-9 PRESS GOX VALVE SENSING LINE

FIGURE 4-2 LOX PRESSURIZATION SYSTEM



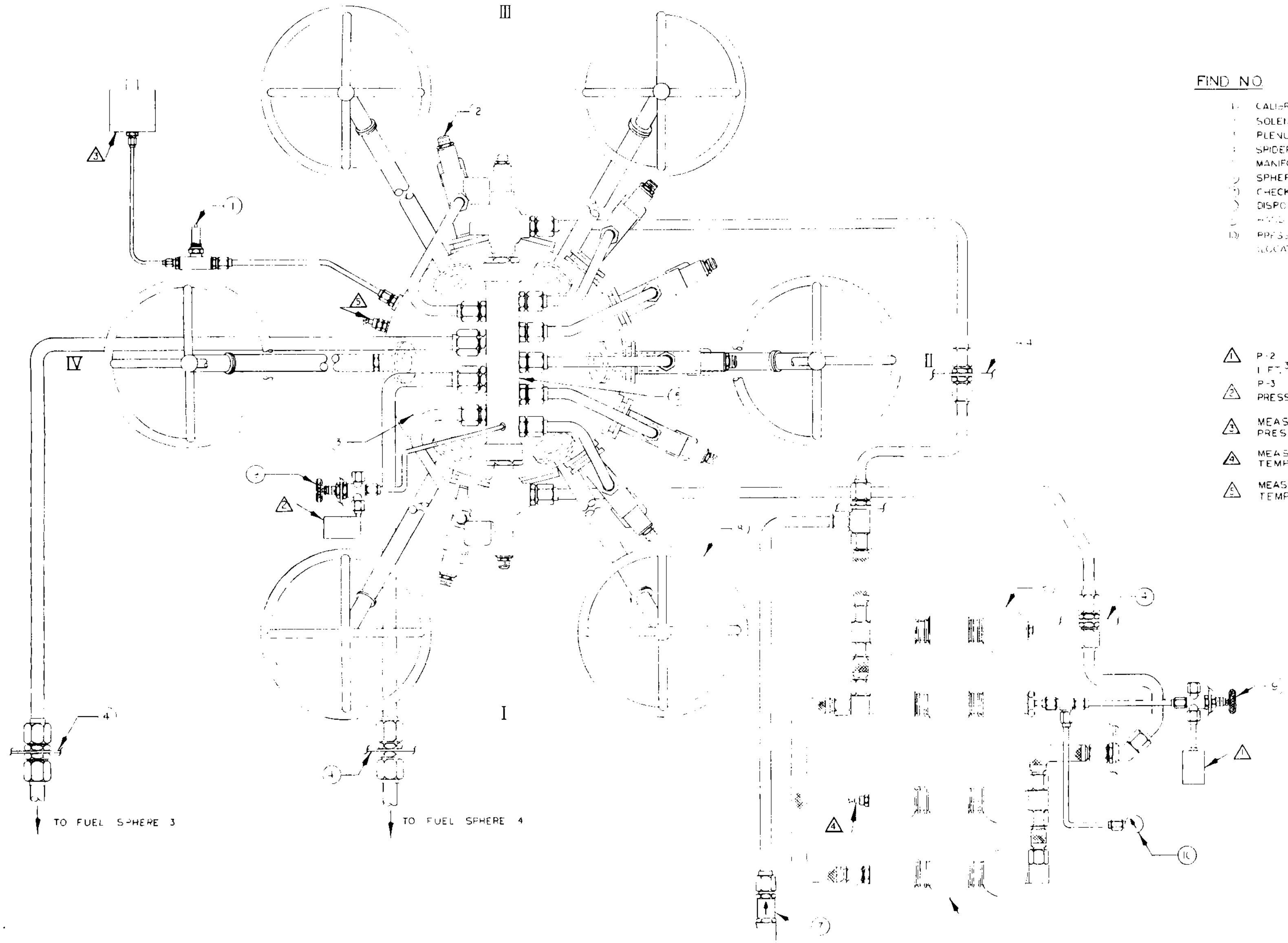
FIND NO.	ITEM
(1)	SOLENOID VALVE
(2)	3 WAY HAND VALVE
(3)	CHECK VALVE
(4)	FUEL PREVALVE (TYPICAL 4 TANKS)
(5)	FUEL VENT VALVE
(6)	MAIN FUEL VALVE (TYPICAL 8 ENGINES)
(7)	CALIBRATION VALVE
(8)	RELIEF VALVE
(9)	FUEL FILL & DRAIN VALVE
(10)	FUEL FILL & DRAIN VALVE CONTROL
(11)	FUEL PRESSURIZING SPHERE (TYPICAL 2 SPHERES)
(12)	FIREWALL
(13)	FUEL CONTAINER PRESSURIZING SPHERE FILL
(14)	FUEL TANK PRESSURIZATION MANIFOLD
(15)	ΔP SLOSH TUBE
(16)	INTERCONNECT (TYPICAL 4 TANKS)
(17)	ENGINE CUT OFF SENSOR
(18)	FUEL DEPLETION SENSOR
(19)	FUEL TURBO PUMP (TYPICAL 8 ENGINES)
(20)	FUEL VENT CONTROL
(21)	FUEL VENT LINE
(22)	FILTER
(23)	FUEL SUCTION LINE (TYPICAL 8 ENGINES)
(24)	FUEL WRAP AROUND LINE OUTBOARD ENGINES NO. 1,2,3, & 4
(25)	FUEL WRAP AROUND LINE INBOARD ENGINES NO. 5,6,7, & 8
(26)	UPPER UMBILICAL C-2
(27)	LOWER UMBILICAL FIN II
(28)	FILL QUICK DISCONNECT UMBILICAL (C-2)
(29)	FUEL BUBBLING LINE
(30)	FUEL BUBBLING SUPPLY
(31)	FUEL TANK PRESSURIZED PRESSURE SWITCH
(32)	CENTER BARREL
(33)	FUEL SPHERE PRESSURIZE PRESSURE SWITCH
(34)	ORIFICE
△1	MEASUREMENT 52.06 FUEL INLET PRESSURIZATION (TYPICAL 8 PLACES)
△2	MEASUREMENT 13.08 TEMPERATURE FUEL PUMP INLET
△3	MEASUREMENT 2.06 FUEL INLET (TYPICAL 8 PLACES)
△4	MEASUREMENT 2.11 FUEL ΔP
△5	MEASUREMENT 2.04-3 (PRESSURE FUEL TANK NO. 3)
△6	FUEL DIFFERENTIAL STEP PRESSURE SWITCH
△7	MEASUREMENT 6.03 FUEL SPHERE PRESSURE
△8	MEASUREMENT 19.45 (ALL) & 19.46 (ALL) ARE EXISTING COMPUTER PROBES
△9	C120-11 TEMP FUEL PRESS. MANIFOLD
△10	MEAS D2-11 PRESS FUEL TANK 1

FIGURE 4-3 FUEL SUPPLY & PRESSURIZATION



FIND NO.	ITEM
1	SPIDER BEAM TYPICAL 4 PLACES
2	LOX RELIEF NO. 1 (O-3)
3	LOX RELIEF NO. 2 (O-4)
4	HIGH PRESSURE SPHERE
5	LOX VENT (O-1)
6	FUEL TANK 3
7	FUEL TANK BRACKET
8	RELIEF VALVE
9	REGULATOR
10	LOX TANK 4
11	MANIFOLD
12	750 P.S.I.G. PRESSURE SWITCH
13	VENT PLATE
14	CHECK VALVE
15	LOWER UMBILICAL FIN IV
16	GN_2 CONTROL PRESSURE FILL
17	HAND VALVE, 3-WAY (3 PLACES)
18	GN_2 SPHERE PRESSURE SWITCH
19	SOLENOID VALVE (TYPICAL 4 PLACES)
20	FILL AND VENT VALVE
21	PREVALVE ORIFICES (TYPICAL 16 PLACES)
22	SOLENOID VALVE (TYPICAL 8 PLACES)
23	FUEL PREVALVE (TYPICAL 8 PLACES)
24	LOX PREVALVE (TYPICAL 8 PLACES)
25	TO GEAR CASE AND LOX SEAL PURGE (8 ENGINES)
26	TO LOX REPLENISH VALVE (NOT INSTALLED FOR STATIC TEST)
27	PREVALVE BLOCKING MANIFOLD (REMOVABLE)
28	MANIFOLD SUPPLY
29	MANIFOLD BLEED
30	EMERGENCY LOX VENT SOLENOID VALVE
31	FACILITY FLEX LINE
32	FILTER (2 PLACES)
△1	MEASUREMENT 6.06 PRESSURE CONTROL SPHERE SUPPLY
△2	MEASUREMENT 5.65 PRESSURE 750 REGULATOR

FIGURE 4-4 GN_2 CONTROL PRESSURE SYSTEM



FIND NO.	ITEM
1	CALIBRATION VALVE
	SOLENOID VALVE (TYPICAL 9 PLACES)
	PLENUM CHAMBER
	SPIDER BEAM (TYPICAL 4 PLACES)
	MANIFOLD
	SPHERE ASSEMBLY (TYPICAL 2 PLACES)
	CHECK VALVE
	DISPOSAL SYSTEM (TYPICAL 6 PLACES)
	VALVE, 3 - WAY (TYPICAL 2 PLACES)
10	PRESSURE GAGE (LOCATED ON TOWER WALL)

1. P-2 PRESSURE TRANSDUCER 1 FT.^{3} SPHERE
2. P-3 PRESSURE TRANSDUCER PRESSURE GN_2 MANIFOLD
3. MEAS NO. D120-II PRESSURE PLENUM CHAMBER
4. MEAS NO. C237-II TEMP LOX SOX SPHERE
5. MEAS NO. C186-II TEMP PLENUM CHAMBER

FIGURE 4-5 LOX-SOX SYSTEM

TABLE 4-1
PROPELLANT LOADING AND PRESSURIZATION DATA

LOX

		Test SA-18	Test SA-19
1.	Tank pressurant	Helium	Helium
2.	Pressurizing orifice dia. (inches)	0.149	0.149
3.	Pressurizing time (seconds)	73.0	99.5
4.	Height from tank bottom at time of pre-pressurization (inches)	620	596
5.	Ullage in gallons at time of pre-pressurization	4470	6230
6.	Ullage in percent at time of pre-pressurization	6.53	10.2
7.	Volume at ignition (gallons)	63,530	61,030
8.	Volume at cutoff (gallons)	47,530	Depleted
9.	Average boiloff rate (gallons/hour)	3060	2370

FUEL

		Test SA-18	Test SA-19
1.	Pressurizing time (seconds)	4.0	3.33
2.	Height from tank bottom at time of pre-pressurization (inches)	616	620
3.	Ullage in gallons at time of pre-pressurization	2080	1790
4.	Ullage in percent at time of pre-pressurization	4.83	4.16
5.	Volume at ignition (gallons)	40,880	41,170
6.	Volume at cutoff (gallons)	31,550	2120

TABLE 4-2
DISCRETE PROBE ACTUATION TIMES*

TEST SA-19

LOX PROBES

TIME FROM (SECONDS)	0-C	0-1	0-2	0-3	0-4
Ignition to P2	8.3	6.7	7.2	7.1	**
P2 to P3	10.0	10.1	10.2	10.0	17.2***
P3 to P4	10.1	10.3	9.9	9.9	10.5
P4 to P5	9.9	10.1	10.5	10.3	10.0
P5 to P6	10.0	10.2	10.4	10.2	10.0
P6 to P7	10.1	10.2	10.1	10.2	10.4
P7 to P8	10.1	10.3	10.2	10.2	10.0
P8 to P9	10.1	10.2	9.9	10.1	10.3
P9 to P10	10.2	10.2	10.3	10.4	10.4
P10 to P11	10.1	10.4	10.4	10.3	10.4
P11 to P12	**	10.2	10.3	10.2	10.1
P12 to P13	20.5***	10.3	**	10.3	10.2
P13 to P14	**	10.3	20.5***	10.2	10.6
P14 to P15	20.2***	10.2	10.4	10.3	10.1

* Times shown are periods in seconds between probe actuations.
** Pulse Lost
*** Accumulative time between probes.

TABLE 4-2 (CONTINUED)

FUEL PROBES

TIME FROM (SECONDS)	F1	F2	F3	F4
Ignition to P1	9.3	9.4	10.0	9.9
P1 to P2	9.9	9.7	9.8	10.0
P2 to P3	9.8	9.7	**	10.0
P3 to P4	9.8	9.9	19.7***	9.9
P4 to P5	10.2	9.3	**	10.0
P5 to P6	10.1	9.4	20.1***	10.0
P6 to P7	9.4	10.2	**	10.2
P7 to P8	9.8	10.2	19.5***	10.2
P8 to P9	10.0	10.3	9.6	9.8
P9 to P10	10.0	10.1	9.7	10.0
P10 to P11	10.0	**	9.7	9.9
P11 to P12	10.0	20.2***	9.8	9.8
P12 to P13	10.1	10.1	9.7	10.0
P13 to P14	9.9	**	9.8	9.9
P14 to P15				

* Times shown are periods in seconds between probe actuations.
** Pulse Lost
*** Accumulative time between probes.

TABLE 4-3
VOLUME BELOW DISCRETE
PROBES FOR STAGE S-I-9

TEST SA-19

LOX
(GALLONS)

PROBE	TANK 0-C	TANK 0-1	TANK 0-2	TANK 0-3	TANK 0-4
P1	22162.0	9963.7	9962.8	9958.2	9960.2
P2	20631.4	9271.4	9272.2	9267.3	9272.8
P3	19095.6	8574.8	8581.6	8576.0	8578.1
P4	17548.8	7887.3	7891.6	7886.9	7886.4
P5	15967.8	7199.1	7202.8	7195.4	7197.9
P6	14408.4	6498.4	6509.9	6503.5	6505.6
P7	12844.8	5813.8	5816.8	5812.6	5814.6
P8	11286.7	5123.3	5126.3	5121.7	5124.7
P9	9730.9	4435.1	4433.5	4432.7	4433.7
P10	8172.1	3739.2	3744.1	3741.8	3743.3
P11	6501.6	3050.4	3054.2	3049.8	3058.1
P12	5067.9	2360.6	2362.4	2360.8	2362.8
P13	3509.9	1662.3	1671.9	1669.9	1672.0
P14	1961.5	980.1	982.5	979.0	980.8
P15	466.0	298.6	301.6	299.1	300.7

TABLE 4-3 (CONTINUED)

FUEL
(GALLONS)

PROBE	TANK F-1	TANK F-2	TANK F-3	TANK F-4
P1	9469.9	9469.6	9472.4	9471.1
P2	8805.4	8805.2	8808.5	8807.5
P3	8153.0	8153.2	8155.9	8155.2
P4	7496.5	7496.5	7499.7	7499.2
P5	6842.0	6841.6	6844.1	6843.3
P6	6177,0	6177.8	6179.5	6177.8
P7	5522.8	5522.8	5525.2	5523.1
P8	4865.6	4866.9	4868.3	4867.1
P9	4200.6	4201.2	4203.2	4201.2
P10	3547.7	3549.8	3549.5	3548.4
P11	2894.7	2895.0	2893.3	2893.2
P12	2336.2	2238.5	2237.0	2235.5
P13	1571.8	1572.7	1571.8	1570.7
P14	919.5	920.8	919.9	918.5
P15	258.7	271.4	272.2	271.8

TABLE 4-4
CONTINUOUS LEVEL PROBE INDICATIONS

TEST SA-19

Continuous Level Probe*	At Inboard Cutoff (Inches)**	At Outboard Cutoff (Inches)**	30 Seconds After Cutoff (Inches)**
FUEL			
A41-F1	39.8	29.7	20.0
A42-F2	39.9	30.6	20.0
A43-F3	***	***	***
A44-F4	33.8	26.3	32.0
LOX			
A45-OC	0.2	0	0
A46-01	0.7	0	0
A47-02	3.1	0	0
A48-03	0.2	0	0
A49-04	0.14	0	0

* Bottom of probe is located 11.2 inches above bottom of propellant tank and has a measuring height of 40.0 inches.
** Inches from bottom of probe.
*** Probe data became erratic 21.4 seconds prior to inboard cutoff.

TABLE 4-5
SIMULATED FLIGHT TEST PREVALVE
CLOSING TIME - AMBIENT TEMPERATURE

Prevalve	Signal-to-Switch (seconds)	Switch-to-Switch (seconds)
LOX No. 1 Fuel No. 1	0.76 1.64	0.40 0.93
LOX No. 2 Fuel No. 2	0.75 1.70	0.39 0.96
LOX No. 3 Fuel No. 3	0.75 1.68	0.39 0.93
LOX No. 4 Fuel No. 4	0.71 1.69	0.35 0.95
LOX No. 5 Fuel No. 5	0.65 1.89	0.35 1.07
LOX No. 6 Fuel No. 6	0.70 1.85	0.37 1.05
LOX No. 7 Fuel No. 7	0.74 1.74	0.35 0.97
LOX No. 8 Fuel No. 8	0.73 1.86	0.36 0.99
LOX (Avg.) Fuel (Avg.)	0.72 1.75	

TABLE 4-6
PROPELLANT LOADING TEST PREVALVE
CLOSING TIME - CRYOGENIC TEMPERATURE

(3 Hour Exposure to LOX)

Prevalve	Signal-to-Switch (seconds)	Switch-to-Switch (seconds)
LOX No. 1	*1.81	0.58
Fuel No. 1	1.68	0.93
LOX No. 2	*1.88	0.66
Fuel No. 2	1.69	0.96
LOX No. 3	1.17	0.45
Fuel No. 3	1.68	0.93
LOX No. 4	*1.80	0.87
Fuel No. 4	1.72	0.92
LOX No. 5	1.68	0.95
Fuel No. 5	1.75	1.06
LOX No. 6	1.53	0.67
Fuel No. 6	1.75	1.03
LOX No. 7	1.13	0.49
Fuel No. 7	1.58	0.97
LOX No. 8	1.21	0.61
Fuel No. 8	1.73	1.00
LOX (Avg.)	1.52	
Fuel (Avg.)	1.70	

* Fuel prevalve closed prior to LOX prevalve.

TABLE 4-7
PREVALVE CLOSING TIME TEST AT
AMBIENT TEMPERATURE - LOX PREVALVE ORIFICES REMOVED

Prevalve	Signal-to-Switch (seconds)	Switch-to-Switch (seconds)
LOX No. 1 Fuel No. 1	0.80 1.65	0.37 0.92
LOX No. 2 Fuel No. 2	0.74 1.70	0.36 0.97
LOX No. 3 Fuel No. 3	0.62 1.69	0.40 0.93
LOX No. 4 Fuel No. 4	0.71 1.73	0.38 0.96
LOX No. 5 Fuel No. 5	0.67 1.87	0.34 1.05
LOX No. 6 Fuel No. 6	0.68 1.84	0.35 1.01
LOX No. 7 Fuel No. 7	0.65 1.70	0.32 0.98
LOX No. 8 Fuel No. 8	0.66 1.80	0.34 0.96
LOX (Avg.) Fuel (Avg.)	0.61 1.74	

TABLE 4-8
PREVALVE CLOSING TIME TEST AT CRYOGENIC TEMPERATURES - LOX PREVALVE ORIFICES REMOVED

(1 Hour Exposure to LOX)

Prevalve	Signal-to-Switch (seconds)	Switch-to-Switch (seconds)
LOX No. 1 Fuel No. 1	0.68 1.56	0.34 0.88
LOX No. 2 Fuel No. 2	0.62 1.58	0.32 0.92
LOX No. 3 Fuel No. 3	0.62 1.58	0.32 0.90
LOX No. 4 Fuel No. 4	0.60 1.58	0.30 0.90
*LOX No. 5 Fuel No. 5	0.56 1.77	0.30 1.02
LOX No. 6 Fuel No. 6	0.60 1.76	0.32 0.96
LOX No. 7 Fuel No. 7	0.56 1.61	0.28 0.93
LOX No. 8 Fuel No. 8	0.57 1.76	0.30 0.96
LOX (Avg.) Fuel (Avg.)	0.60 1.65	

* Prevalve changed after test.

TABLE 4-9
PREVALVE CLOSING TIMES - TEST SA-18

(4 Hour Exposure to LOX)

Prevalve	Signal-to-Switch (seconds)	Switch-to-Switch (seconds)
LOX No. 1 Fuel No. 1	0.97 1.64	0.41 0.92
LOX No. 2 Fuel No. 2	0.88 1.65	0.42 0.94
LOX No. 3 Fuel No. 3	0.84 1.64	0.42 0.91
LOX No. 4 Fuel No. 4	0.85 1.72	0.43 0.46
LOX No. 5 Fuel No. 5	0.79 1.86	0.39 1.06
LOX No. 6 Fuel No. 6	0.87 1.79	0.45 0.99
LOX No. 7 Fuel No. 7	0.76 1.62	0.39 0.93
LOX No. 8 Fuel No. 8	0.77 1.79	0.38 0.99
LOX (Avg.) Fuel (Avg.)	0.84 1.71	

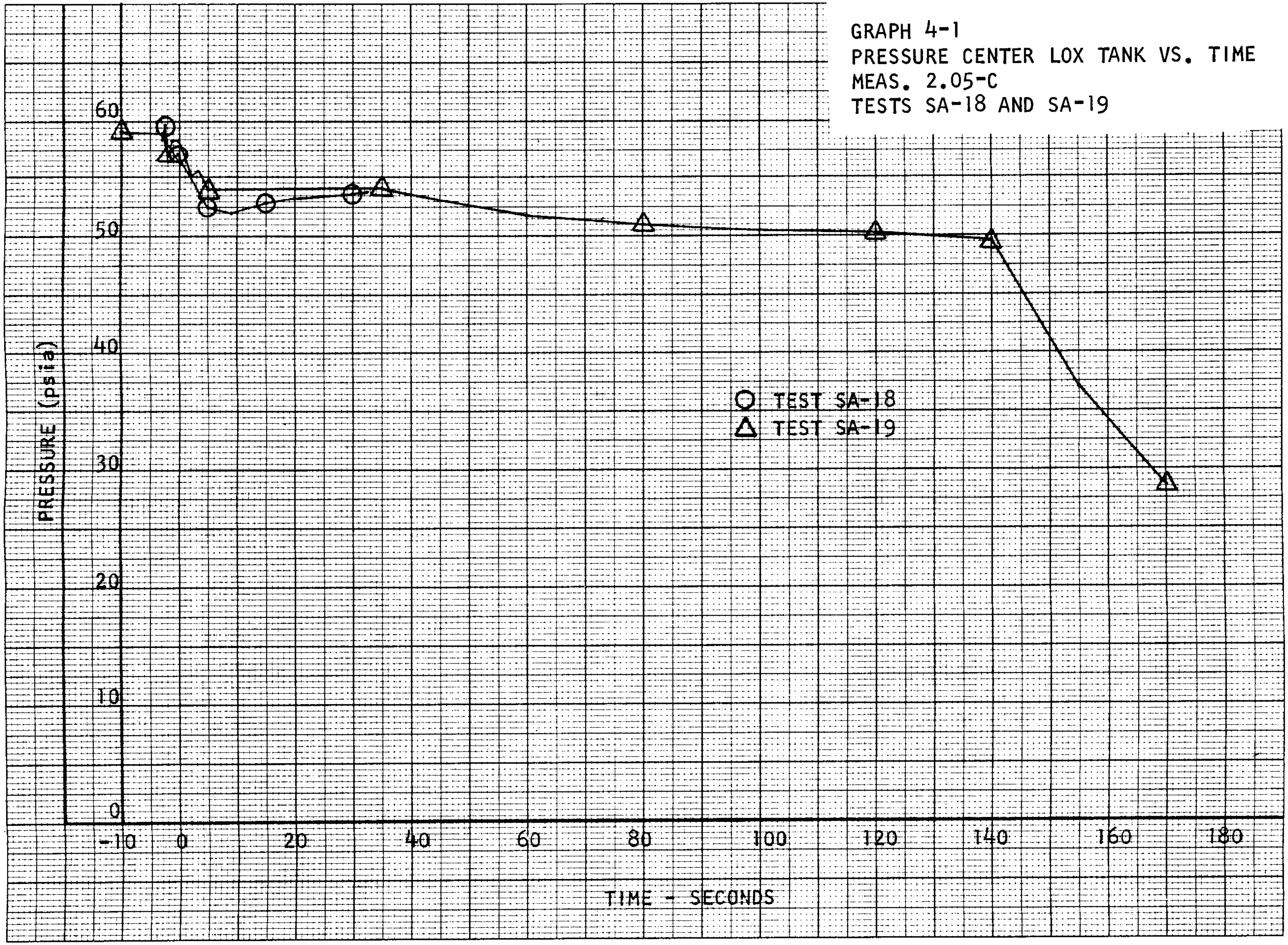
TABLE 4-10
PREVALVE CLOSING TIMES - TEST SA-19

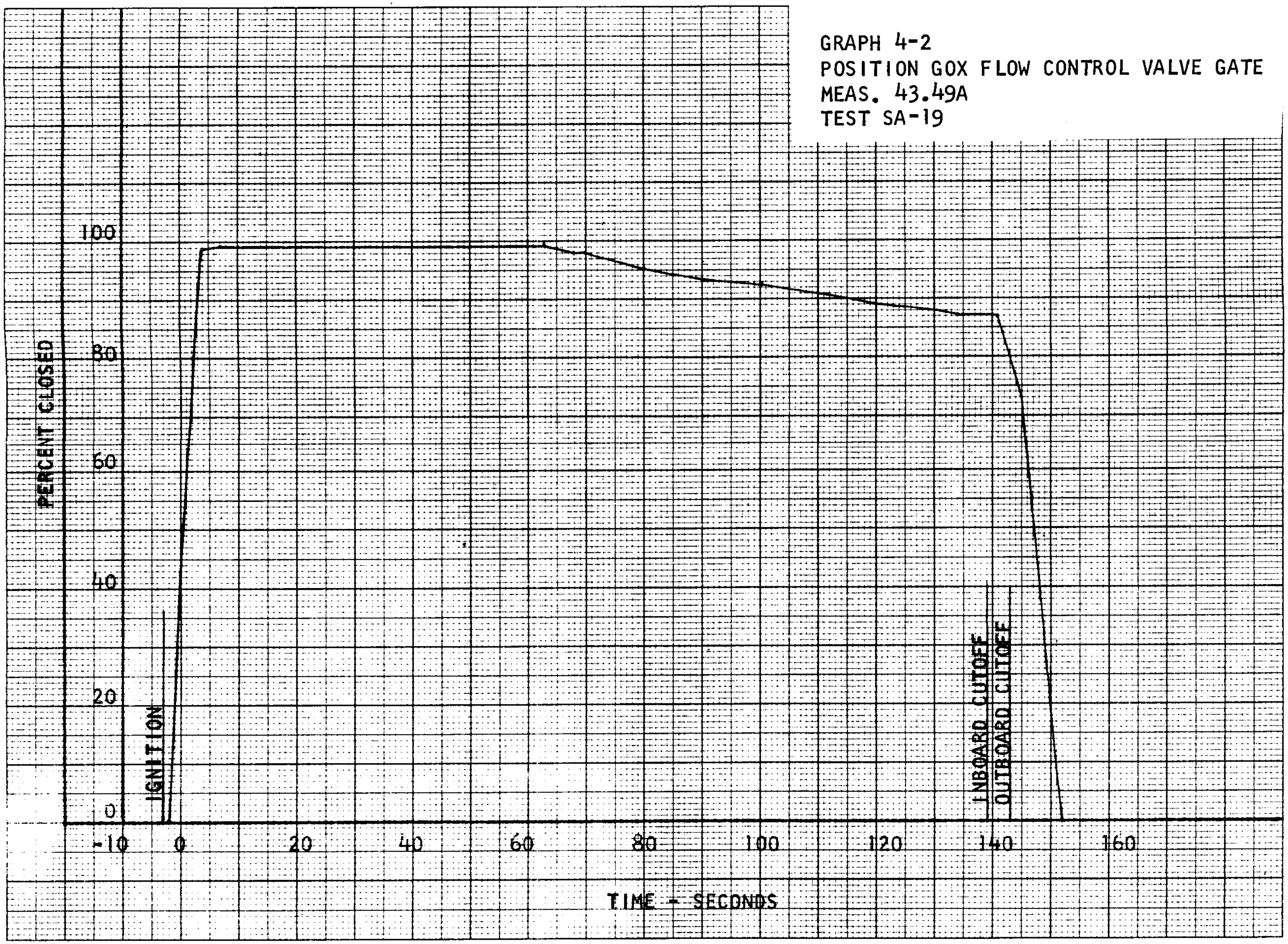
(7 Hour Exposure to LOX)

Prevalve	Signal-to-Switch (seconds)	Switch-to-Switch (seconds)
LOX No. 1 Fuel No. 1	1.54 1.62	0.57 0.89
LOX No. 2 Fuel No. 2	1.36 1.64	0.72 0.93
LOX No. 3 Fuel No. 3	1.26 1.65	0.70 0.90
LOX No. 4 Fuel No. 4	1.12 1.67	0.65 0.92
LOX No. 5 Fuel No. 5	1.07 1.85	0.45 1.03
LOX No. 6 Fuel No. 6	1.40 1.79	0.87 0.88
LOX No. 7 Fuel No. 7	1.07 1.67	0.51 0.95
LOX No. 8 Fuel No. 8	*2.04 1.80	1.21 0.95
LOX (Avg.) Fuel (Avg.)	1.52 1.62	

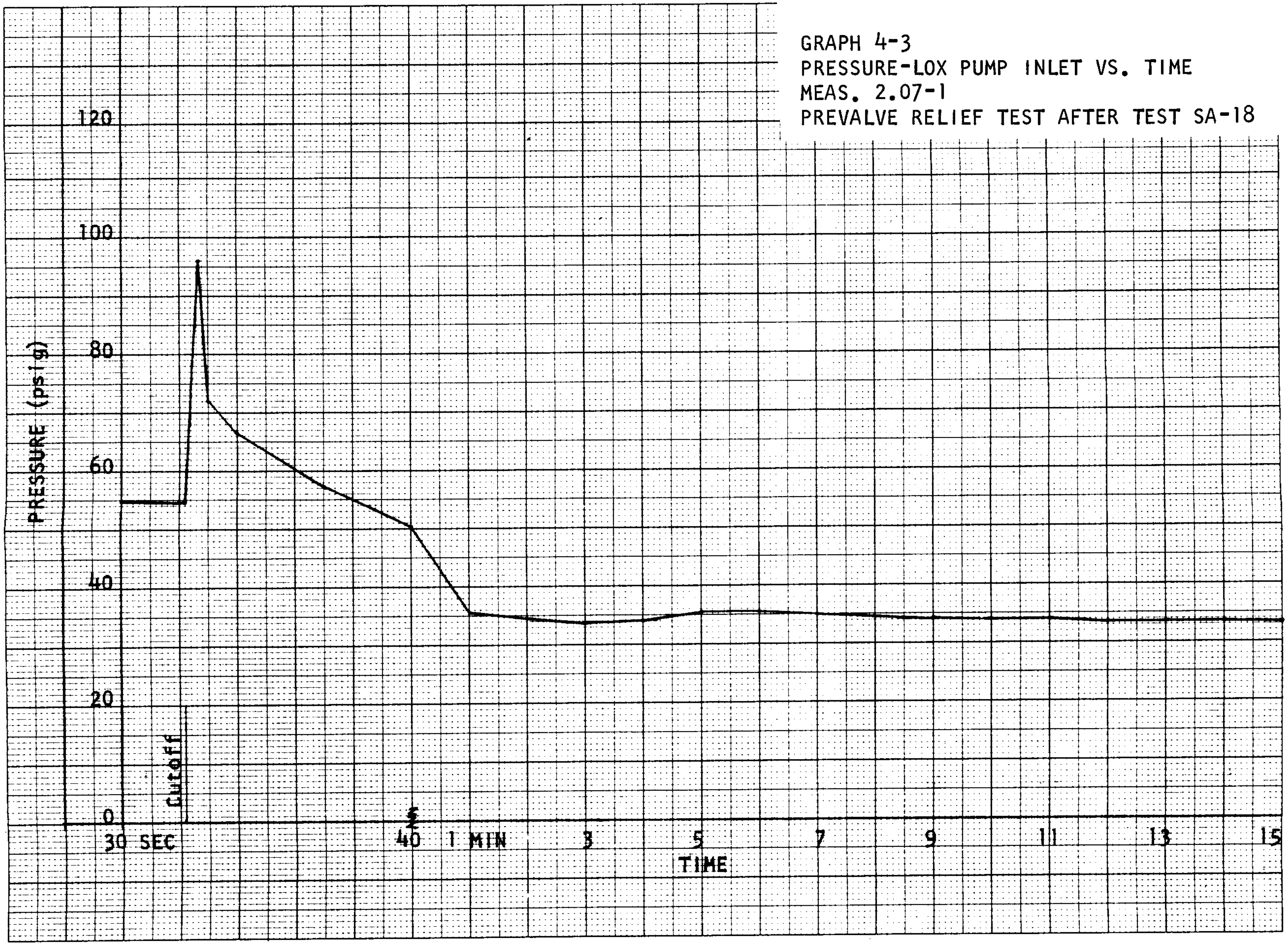
* Fuel prevalve closed prior to LOX prevalve.

GRAPH 4-1
PRESSURE CENTER LOX TANK VS. TIME
MEAS. 2.05-C
TESTS SA-18 AND SA-19

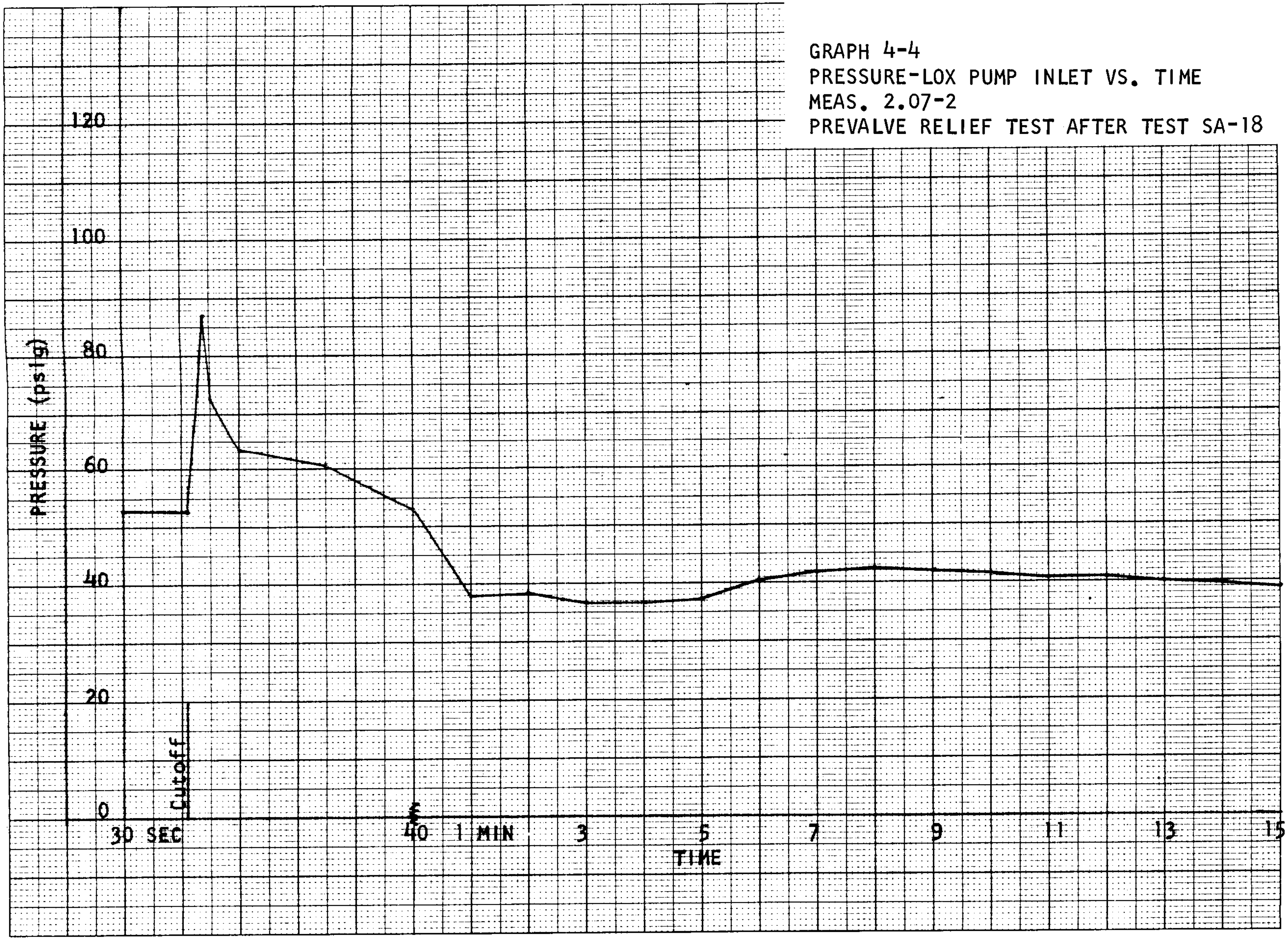



GRAPH 4-2
POSITION GOX FLOW CONTROL VALVE GATE
MEAS. 43.49A
TEST SA-19
PERCENT CLOSED
100
80
60
40
20
0
-10
0
20
40
60
80
100
120
140
160
IGNITION
INBOARD CUTOFF
OUTBOARD CUTOFF
TIME - SECONDS

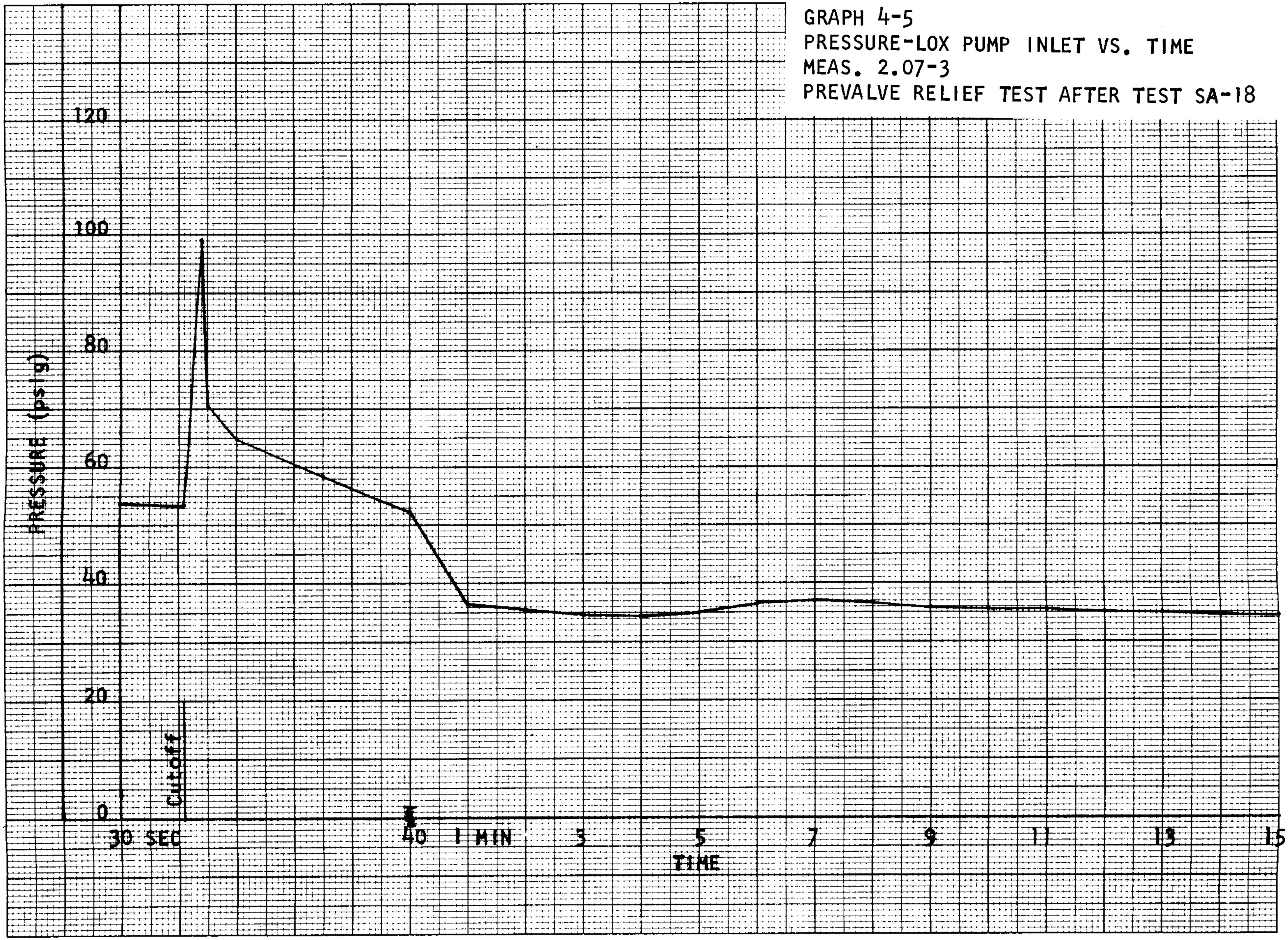
GRAPH 4-3
PRESSURE-LOX PUMP INLET VS. TIME
MEAS. 2.07-1
PREVALVE RELIEF TEST AFTER TEST SA-18

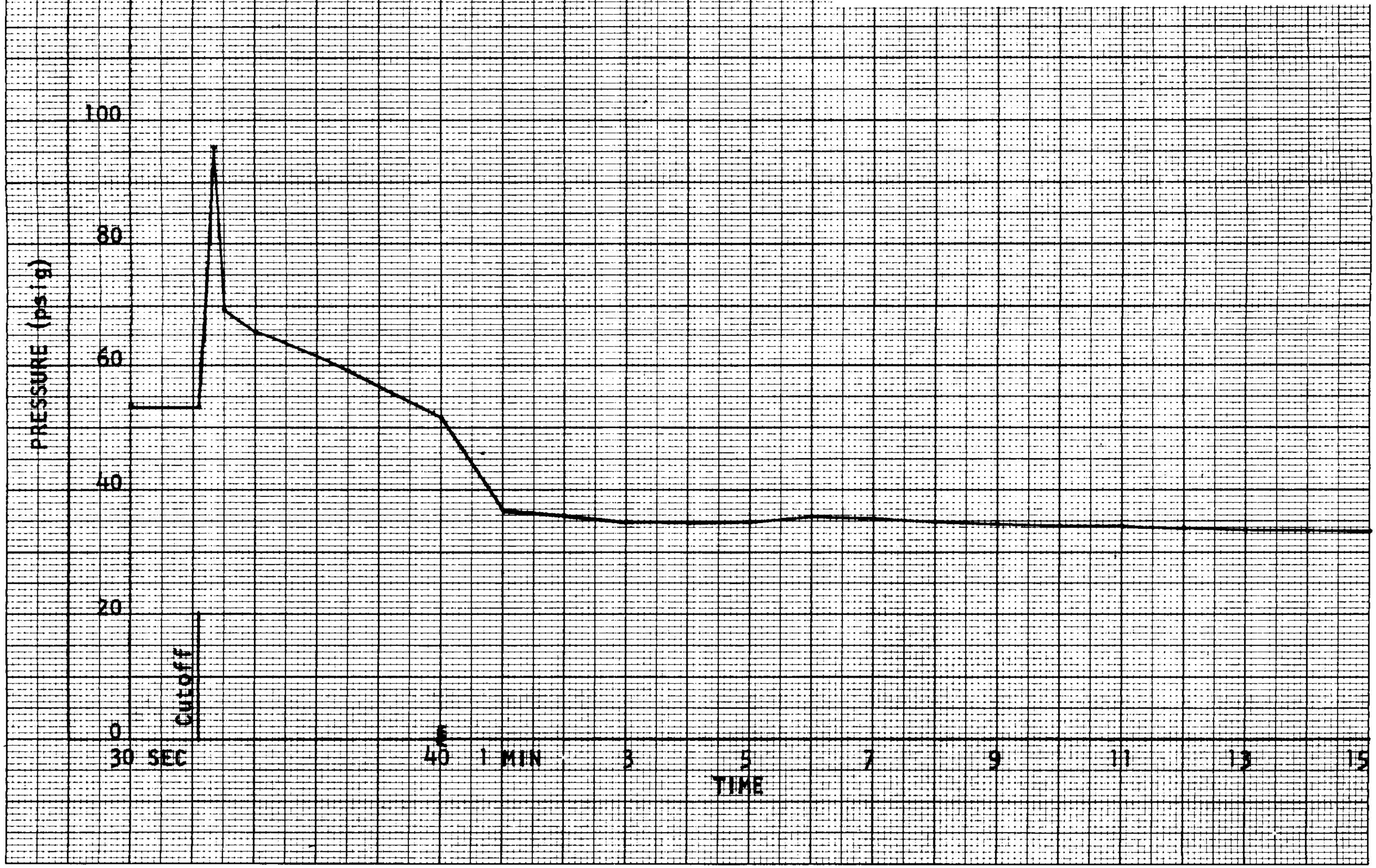


GRAPH 4-4
PRESSURE-LOX PUMP INLET VS. TIME
MEAS. 2.07-2
PREVALVE RELIEF TEST AFTER TEST SA-18

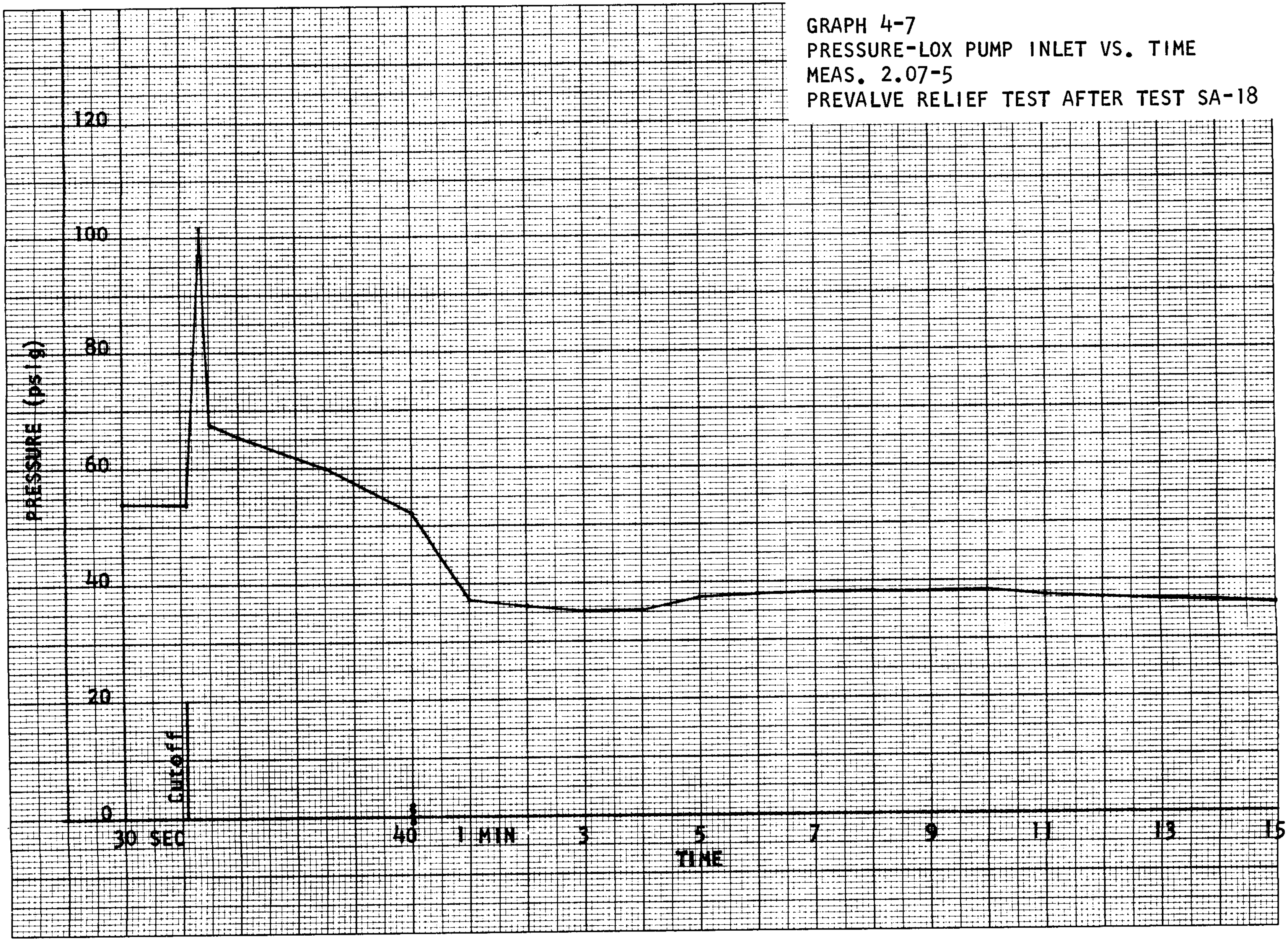


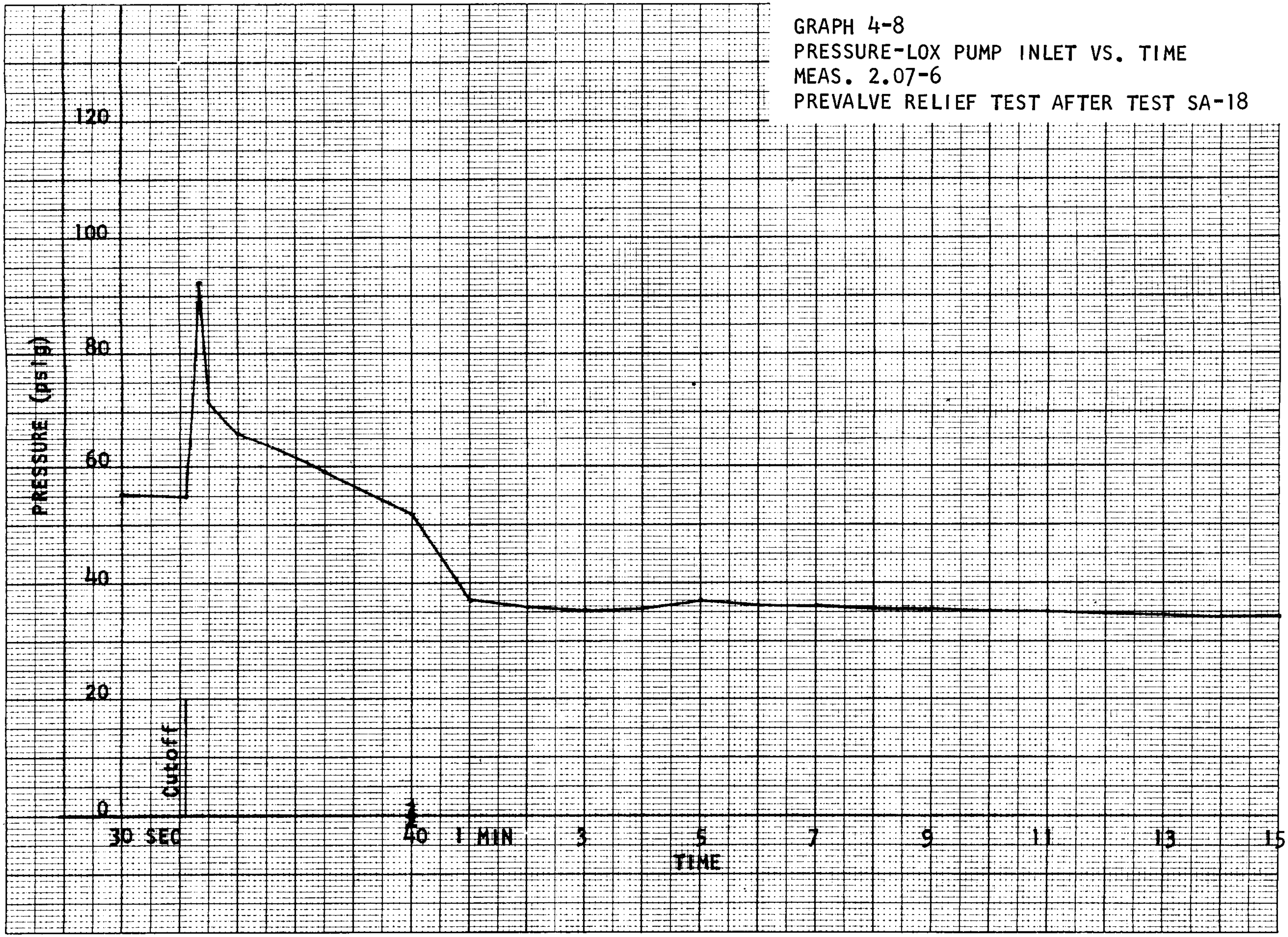
GRAPH 4-5
PRESSURE-LOX PUMP INLET VS. TIME
MEAS. 2.07-3
PREVALVE RELIEF TEST AFTER TEST SA-18





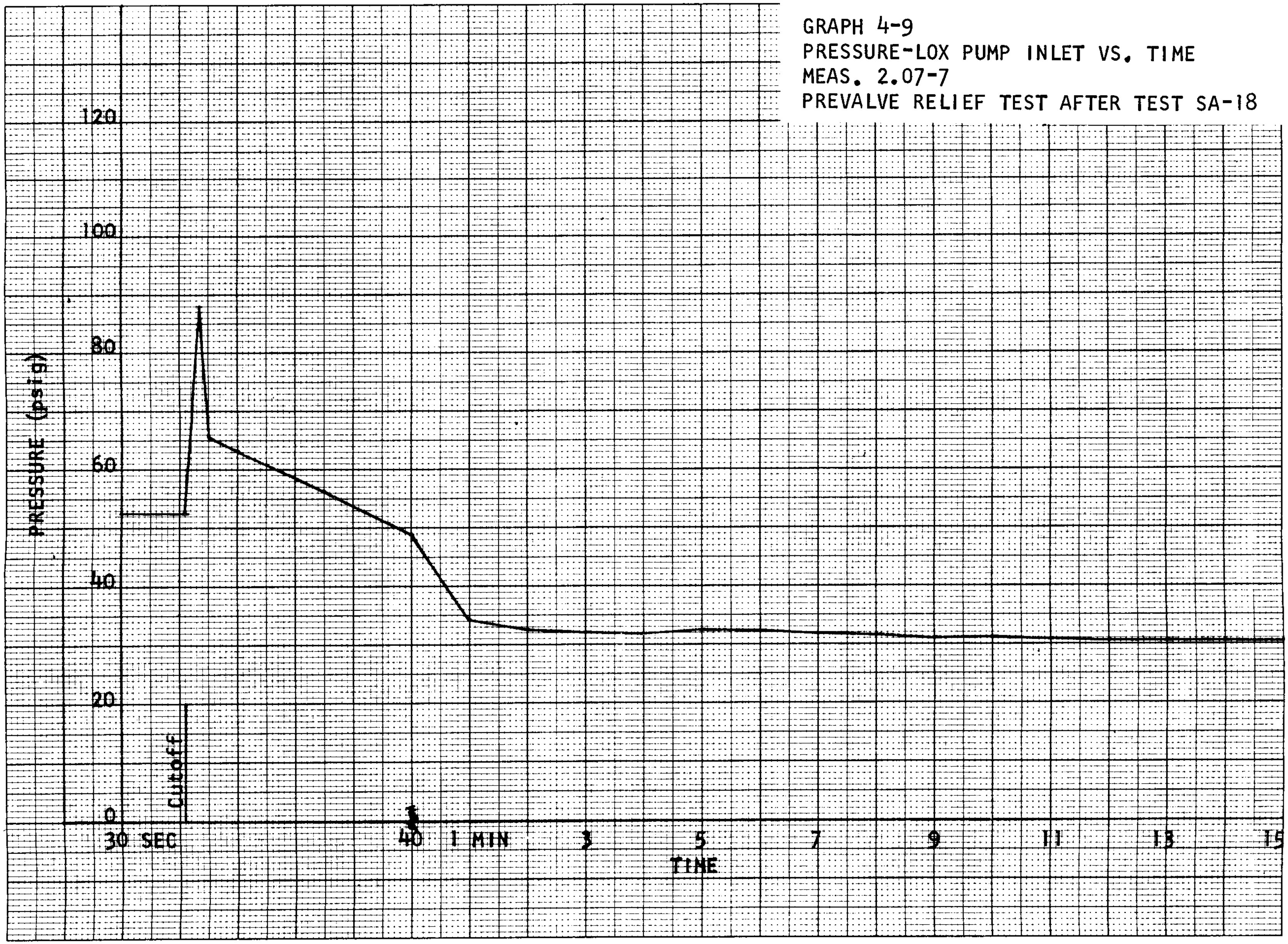
GRAPH 4-6
PRESSURE-LOX PUMP INLET VS. TIME
MEAS. 2.07-4
PREVALVE RELIEF TEST AFTER TEST SA-18

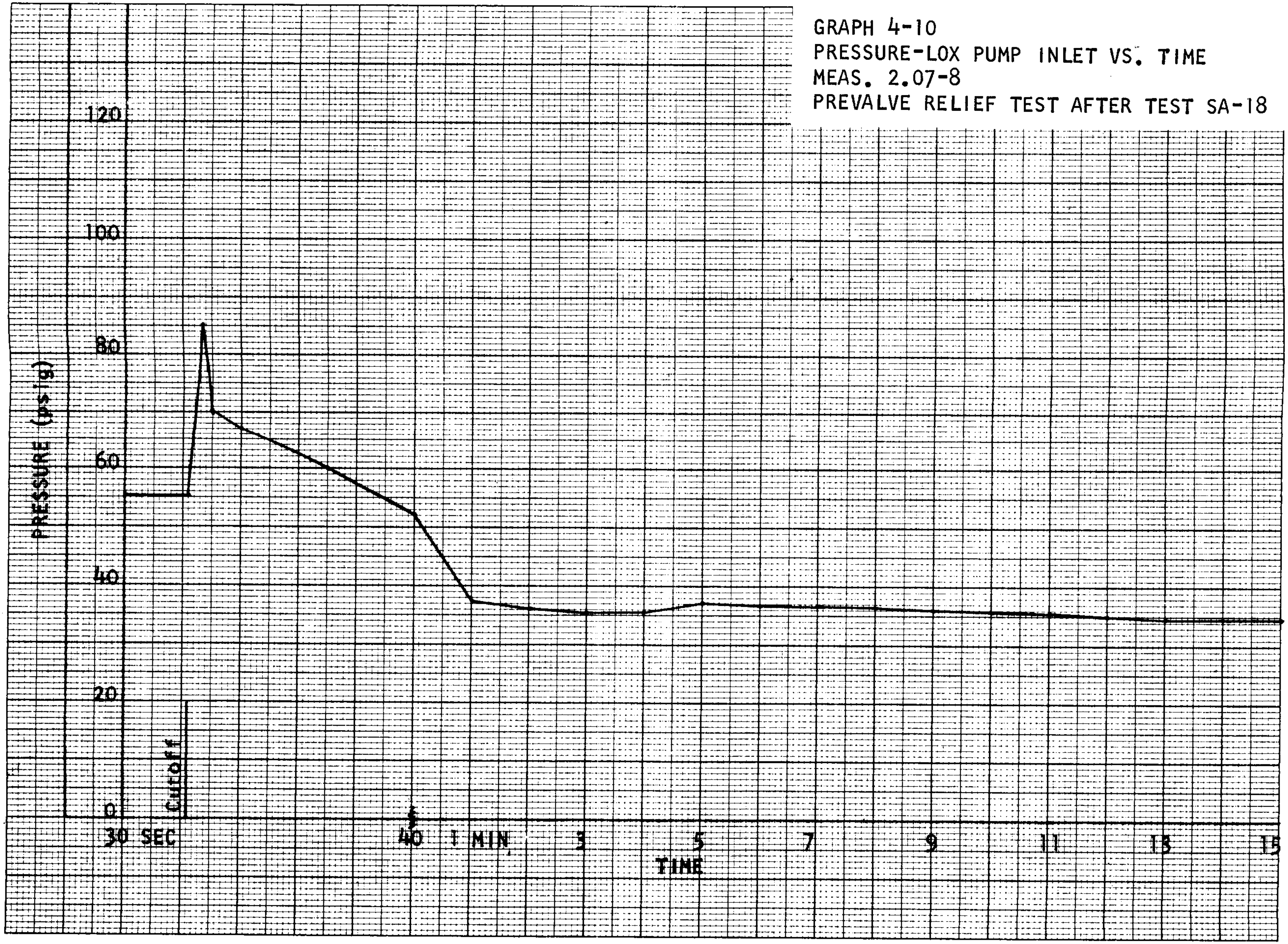

GRAPH 4-7
PRESSURE-LOX PUMP INLET VS. TIME
MEAS. 2.07-5
PREVALVE RELIEF TEST AFTER TEST SA-18
PRESSURE (psig)
120
100
80
60
40
20
0
CUTOFF
30 SEC
40
1 MIN
3
5
7
9
11
13
15
TIME



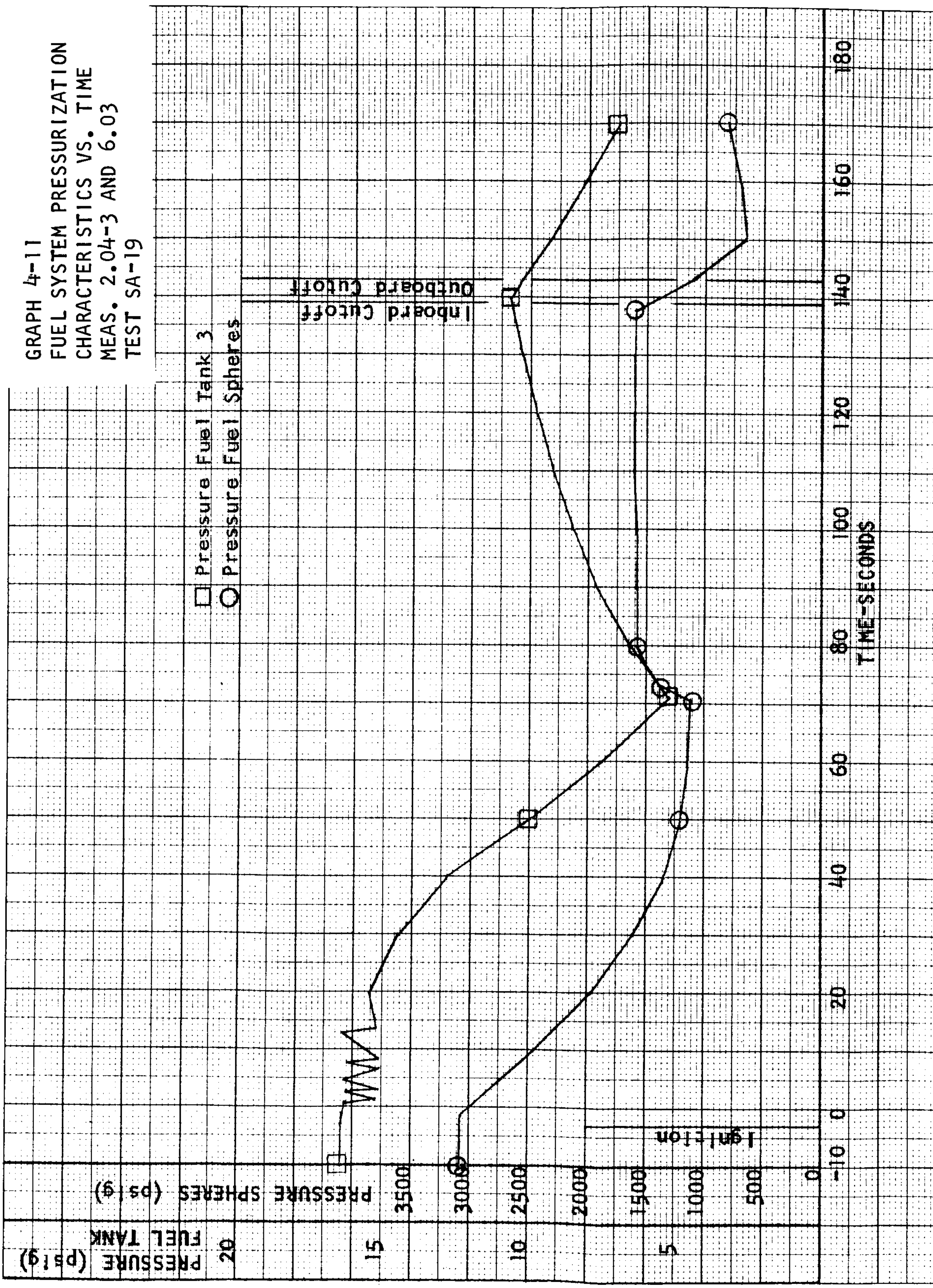
GRAPH 4-8
PRESSURE-LOX PUMP INLET VS. TIME
MEAS. 2.07-6
PREVALVE RELIEF TEST AFTER TEST SA-18

GRAPH 4-9
PRESSURE-LOX PUMP INLET VS. TIME
MEAS. 2.07-7
PREVALVE RELIEF TEST AFTER TEST SA-18



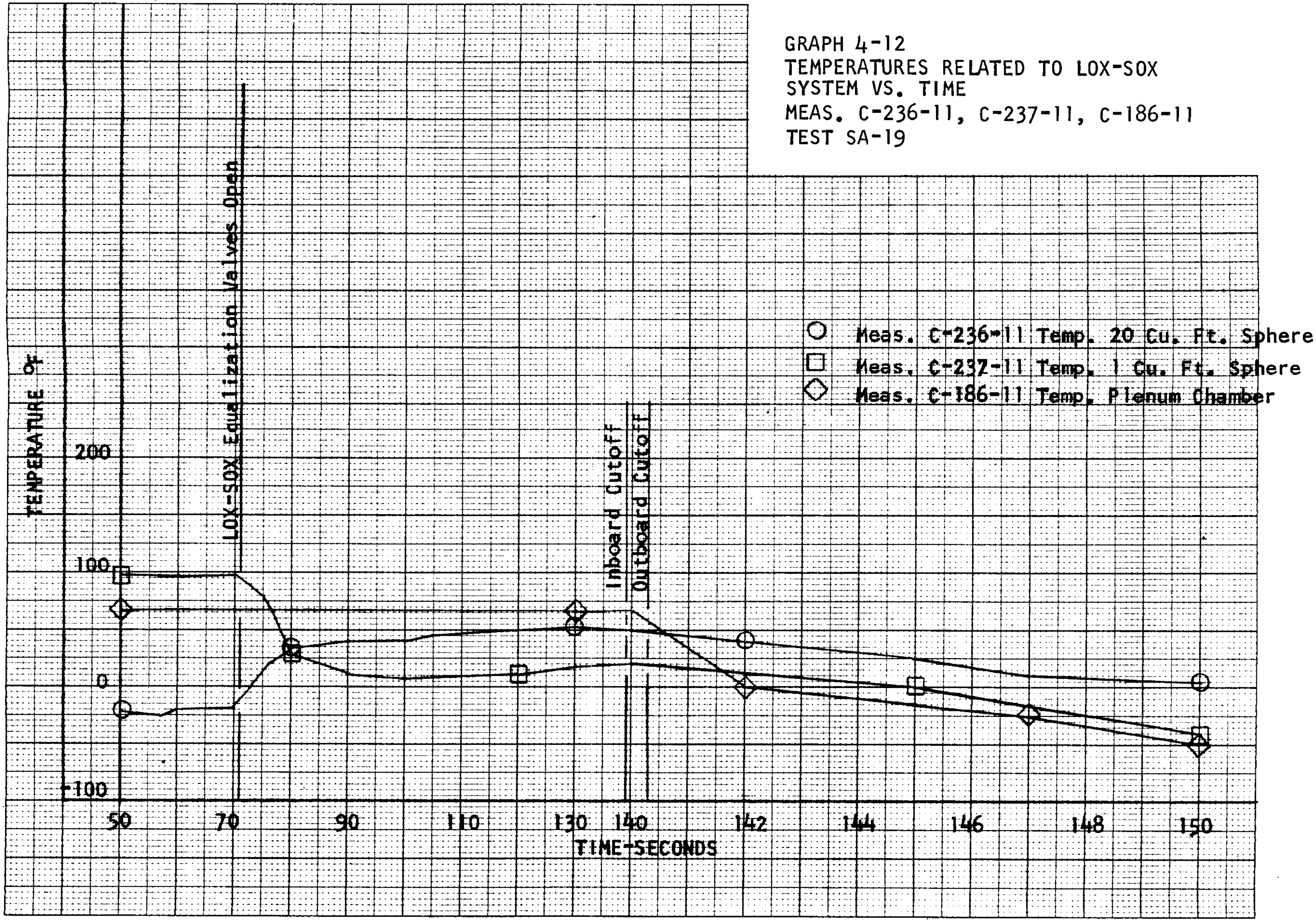


GRAPH 4-10
PRESSURE-LOX PUMP INLET VS. TIME
MEAS. 2.07-8
PREVALVE RELIEF TEST AFTER TEST SA-18

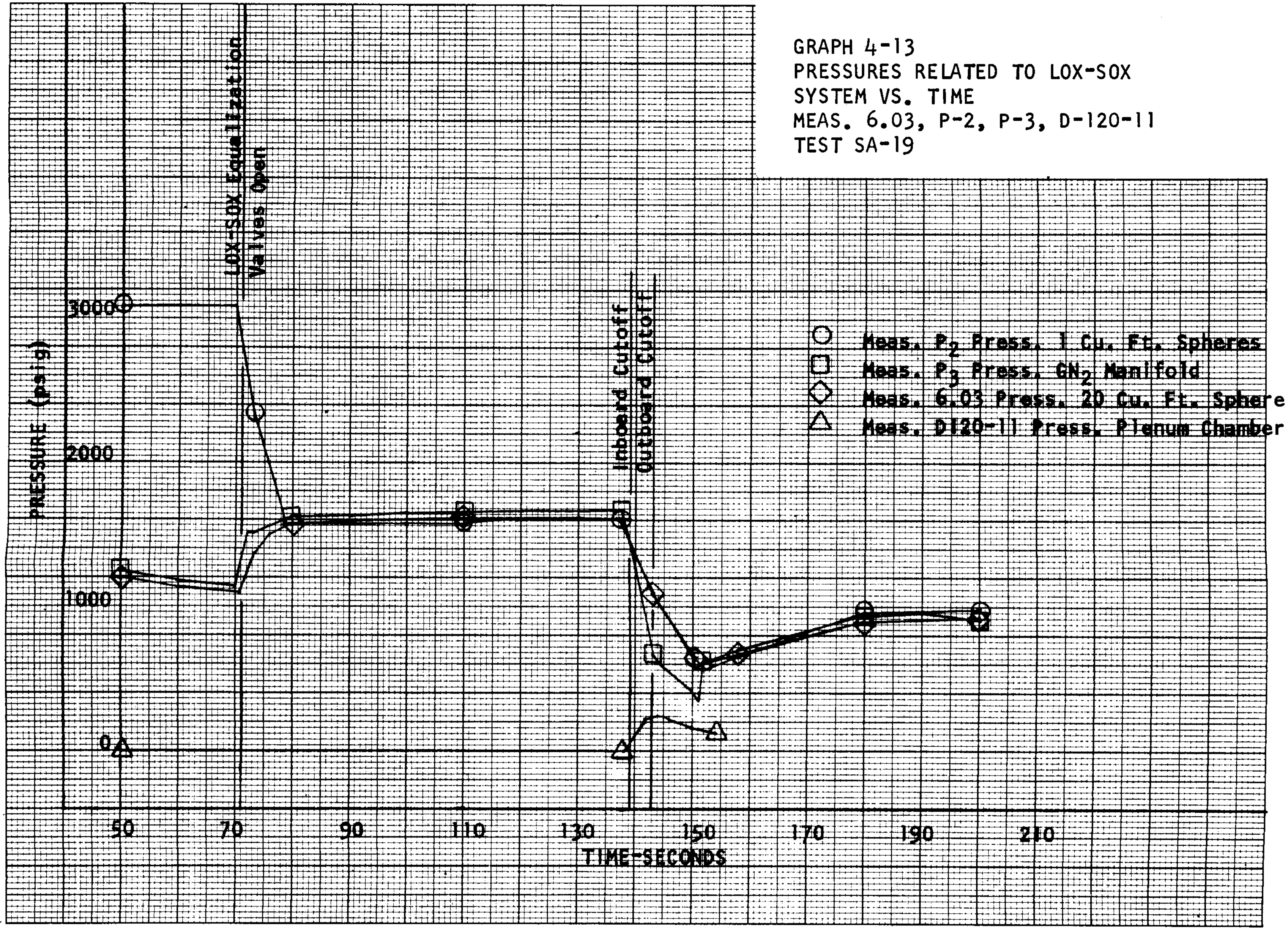


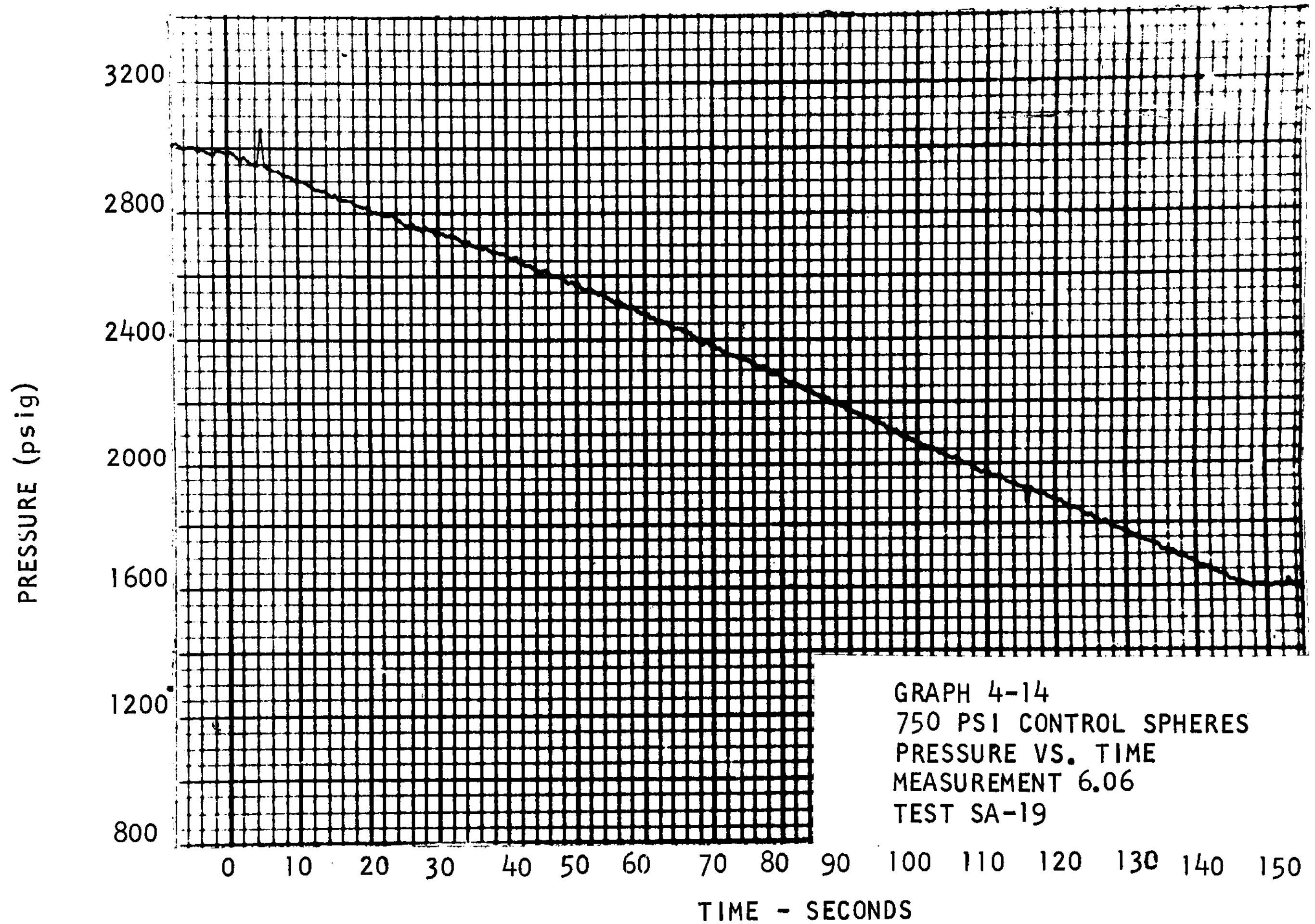
GRAPH 4-11
FUEL SYSTEM PRESSURIZATION
CHARACTERISTICS VS. TIME
MEAS. 2.04-3 AND 6.03
TEST SA-19

GRAPH 4-12
TEMPERATURES RELATED TO LOX-SOX
SYSTEM VS. TIME
MEAS. C-236-11, C-237-11, C-186-11
TEST SA-19



GRAPH 4-13
PRESSURES RELATED TO LOX-SOX
SYSTEM VS. TIME
MEAS. 6.03, P-2, P-3, D-120-11
TEST SA-19





GRAPH 4-14
750 PSI CONTROL SPHERES
PRESSURE VS. TIME
MEASUREMENT 6.06
TEST SA-19

SECTION 5
ENGINE COMPARTMENT ENVIRONMENT

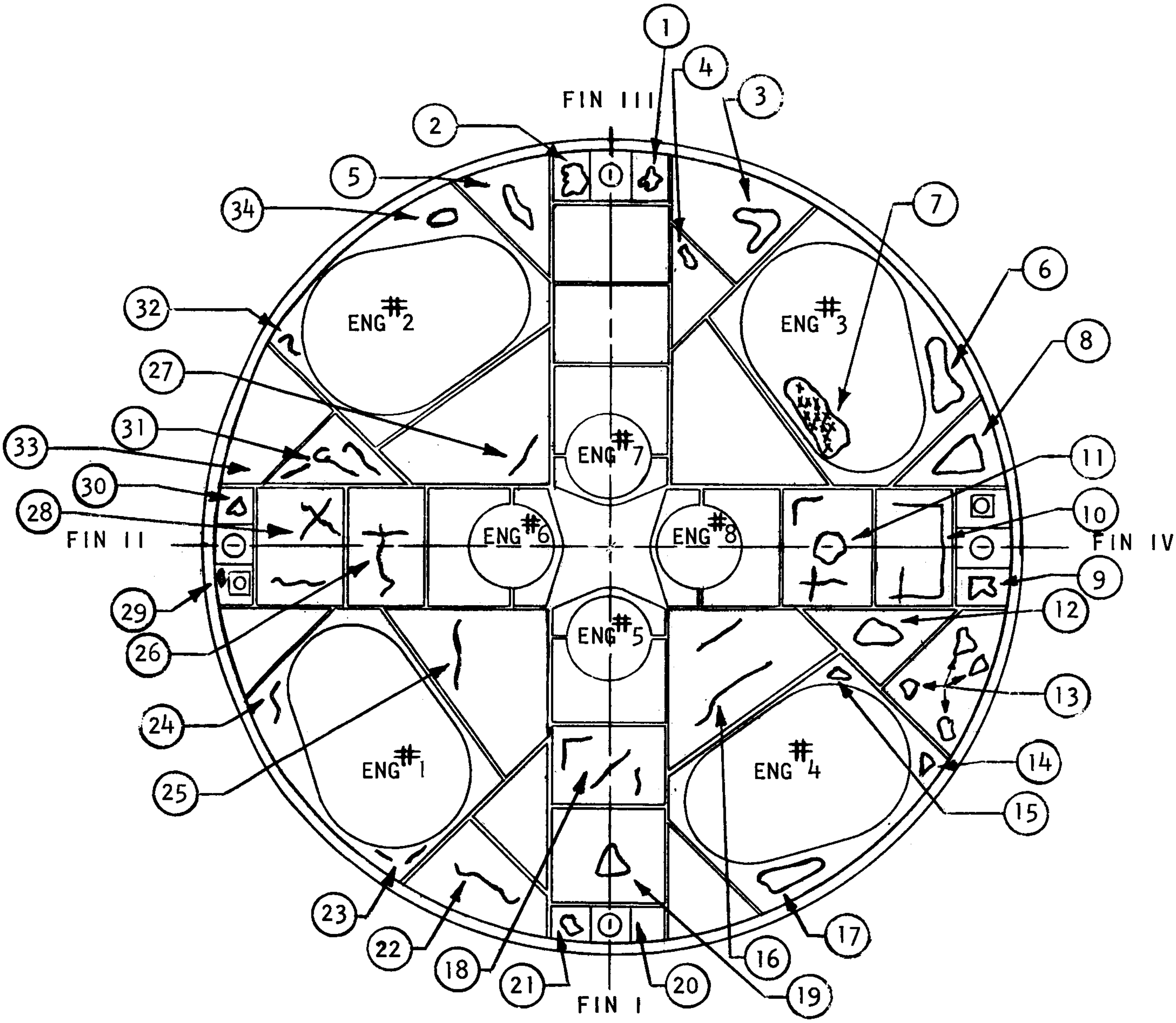
Post-test inspection of the engine compartment and lower stage structure revealed no visual evidence of overheating during test SA-18. Damage to the heat shield was minor. All four aspirator covers had missing reflective material and frayed base material which were repaired prior to test SA-19. Engine curtain damage was negligible during test SA-18.

Post-test inspection, following test SA-19, revealed severe damage to the heat shield. Approximately 1700 square inches of M-31 insulation material separated from the stage panels. Insulation which remained was cracked in many places. The post-test status of the individual panels is shown in FIGURE 5-1 and TABLE 5-1.

During test SA-19 the Fiberglas heat shield curtain on engine 3 was extensively torn, and the exposed flexible gimbal boot was burned on the surface but not penetrated. Pretest inspection had revealed a small tear 5 inches long in the inboard quadrant of the Fiberglas curtain on engine 3. This tear was repaired prior to test SA-19 with reflective tape but was inadequate. The damaged Fiberglas heat shield curtain is a static test item only and had been used during static testing of the last three stages. All engine curtains will be replaced prior to flight.

Turbine spinner surface temperatures were maintained within the specified limits (40° F to 75° F) by the boattail conditioning system for tests SA-18 and SA-19.

There was no evidence of fire or hot gas leaks in the engine compartment during tests SA-18 and SA-19.



AFT LOOKING FORWARD

TEST SA-19

HEAT SHIELD DAMAGE

DAMAGE DESCRIBED IN TABLE 5-1

FIGURE 5-1

TABLE 5-1
HEAT SHIELD DAMAGE

REFERENCE FIG. 5-1	EXTENT OF DAMAGE
1	140 $in.^2$ piece of M-31 material had fallen away.
2	80 $in.^2$ piece had fallen away.
3	260 $in.^2$ piece of the panel had fallen away; the remainder of the panel was cracked badly and was loose.
4	48 $in.^2$ piece had fallen away; the remainder of the panel was severely cracked.
5	170 $in.^2$ piece had fallen away.
6	90 $in.^2$ piece had separated; the remainder of the panel was cracked and loose.
7	Engine 3 curtain was severely torn and burned; rubber boot was still intact.
8	180 $in.^2$ had separated.
9	60 $in.^2$ had separated.
10	Entire panel was severely cracked; glass was missing from calorimeter.
11	30 $in.^2$ had separated; remainder of panel was severely cracked.
12	150 $in.^2$ had fallen away.
13	Total of 100 $in.^2$ had separated in four different areas.
14	25 $in.^2$ had separated.
15	8 $in.^2$ had fallen away.
16	Crack 14 inches long appeared as shown.

TABLE 5-1 (CONTINUED)

REFERENCE FIG. 5-1	EXTENT OF DAMAGE
17	150 in.^{2} had separated.
18	Entire panel was badly cracked.
19	20 in.^{2} had separated; remainder of panel was loose.
20	Entire panel was cracked and loose.
21	50 in.^{2} had separated.
22	Panel had a crack 15 inches long.
23	Crack 5 inches long appeared as shown.
24	Crack 5 inches long appeared as shown.
25	Crack 24 inches long appeared as shown.
26	Crack appeared as shown; each crack was approximately 12 inches long.
27	Crack 12 inches long.
28	Two cracks appeared as shown, 6 and 10 inches long.
29	45 in.^{2} had separated.
30	70 in.^{2} had fallen away; remainder of the panel was badly cracked.
31	Panel was cracked as shown; entire panel was loose and bulging.
32	Crack 10 in. long.
33	Panel was intact but was severely cracked, loose, and bulging.
34	90 in.^{2} had separated; remainder of panel was loose.

SECTION 6
VIBRATION AND SPECIAL INSTRUMENTATION

A detailed discussion of the vibration and acoustic measurement data for tests SA-18 and SA-19 is published in the Vibration and Acoustic Evaluation Report by Systems Static Test Branch. Also included in this report is a discussion of the rough combustion cutoff (RCC) systems.

The fire detection system functioned as required for tests SA-18 and SA-19, and no abnormal temperatures were detected. The fire detection system configuration was the same for tests SA-18 and SA-19. The system consisted of 12 Test Laboratory harnesses and 4 flight harnesses. Each rise rate indicator was set at 5 chart scales per second (2.5 mv) with a time delay of 1 second for the Test Laboratory harnesses and a time delay of one-half second for the flight harnesses. All 16 rise rate indicators were active in the cutoff circuit.

As requested in NASA Memorandum R-P&VE-VF-234-64, radiation calorimeters were installed on the test tower to measure the radiant energy of the exhaust plume during tests SA-18 and SA-19. Results from these measurements are presented in the PSTR's for tests SA-18 and SA-19.

SECTION 7
ELECTRICAL CONTROL SYSTEMS

Saturn stage S-I-9 underwent electrical system verification during prestatic testing and static firings while at Test Laboratory.

Commencing with test SA-18, the automatic countdown sequence times were changed to agree with those of the launch countdown at Cape Kennedy. Times at which the automatic sequence commands occurred were:

Firing Command	X-153
End LOX Bubbling	X-103
Power Transfer	X-28
Ignition	X-3
Commit	X-0

Ignition command (X-3 seconds), or pulse override on the strip chart and oscillograph records, occurred at 13:35:32.59 CST on test SA-19. Zero time was recorded as 13:35:32 on all telemetry records. Both these times were incorrectly published in the PSTR for test SA-19. Action has been taken to coordinate a change in zero time on millisadic and oscillograph systems from ignition command to commit for test SA-20 and subsequent. This will maintain continuity between hardwire, telemetry, and launch records.

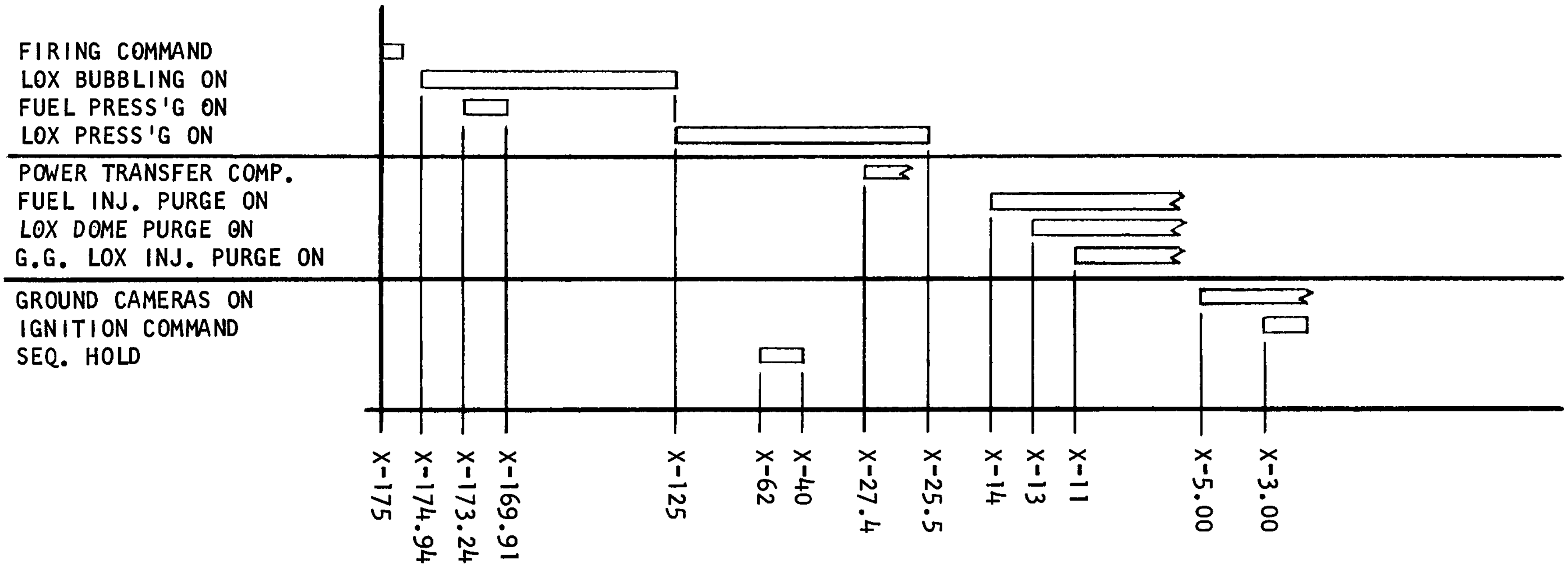
All operations were performed normally during test SA-18 with the exception of the Heat Manifold Purge Sequence Pen which did not pick up. This malfunction was caused by a pressure switch that did not actuate. The switch was repaired and performed correctly for test SA-19.

The rate gyro oscillograph data from tests SA-18 and SA-19 were taken directly from the telemeter output, band 2. The frequency response of band 2 is limited to a maximum of 8.4 cps; consequently, no frequencies higher than this level are recorded on the oscillograph records.

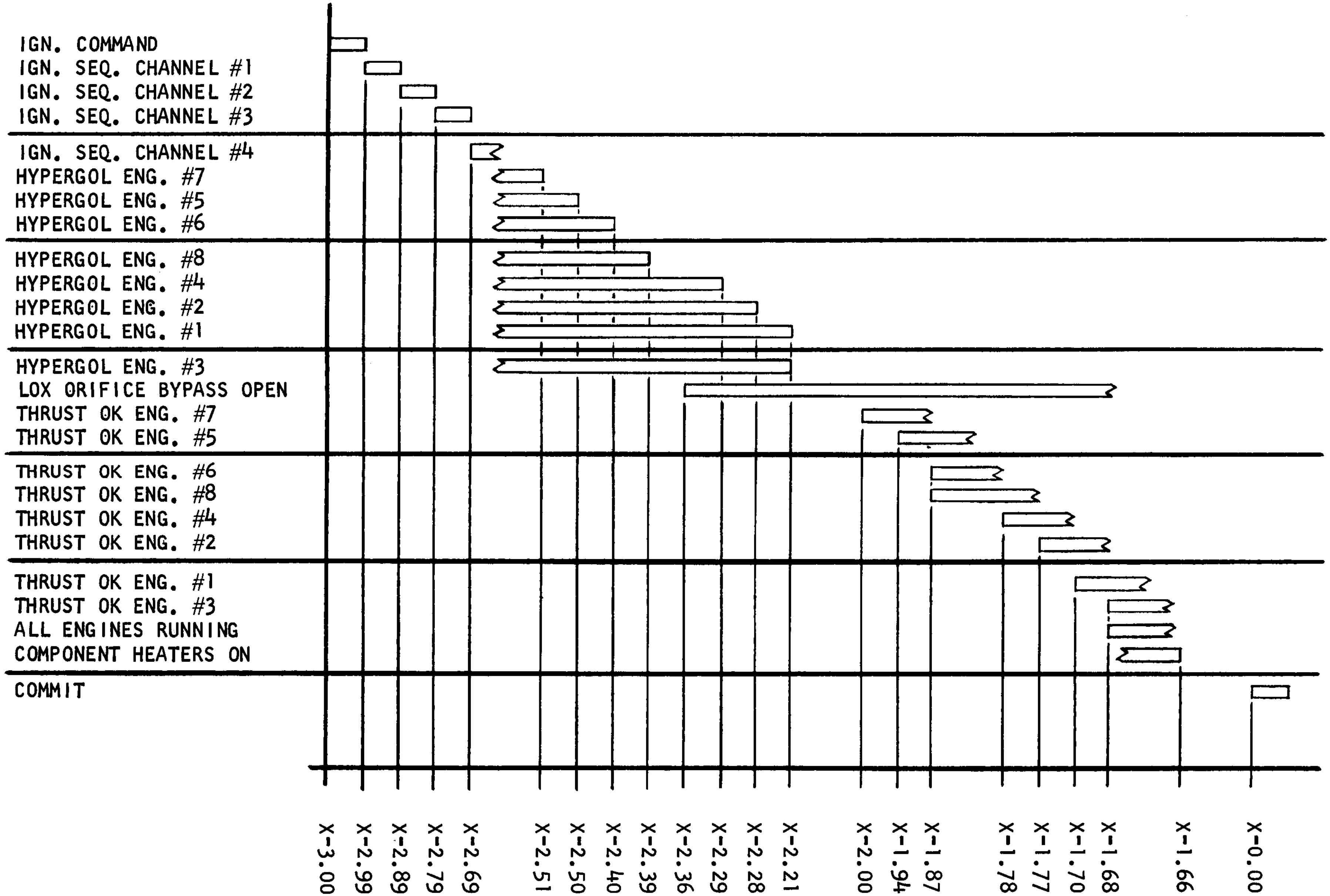
The explosive bridge wire (EBW) system control panels, which are obtained from NASA Quality Assurance and Reliability Laboratory on a loan basis, were sent to CCSD-Michoud. Due to insufficient time for checkout after the panels were returned, the EBW system was not installed for test SA-19.

Operating times for major functions on test SA-19 are included on the enclosed bar charts (see FIGURES 7-1 through FIGURE 7-4).

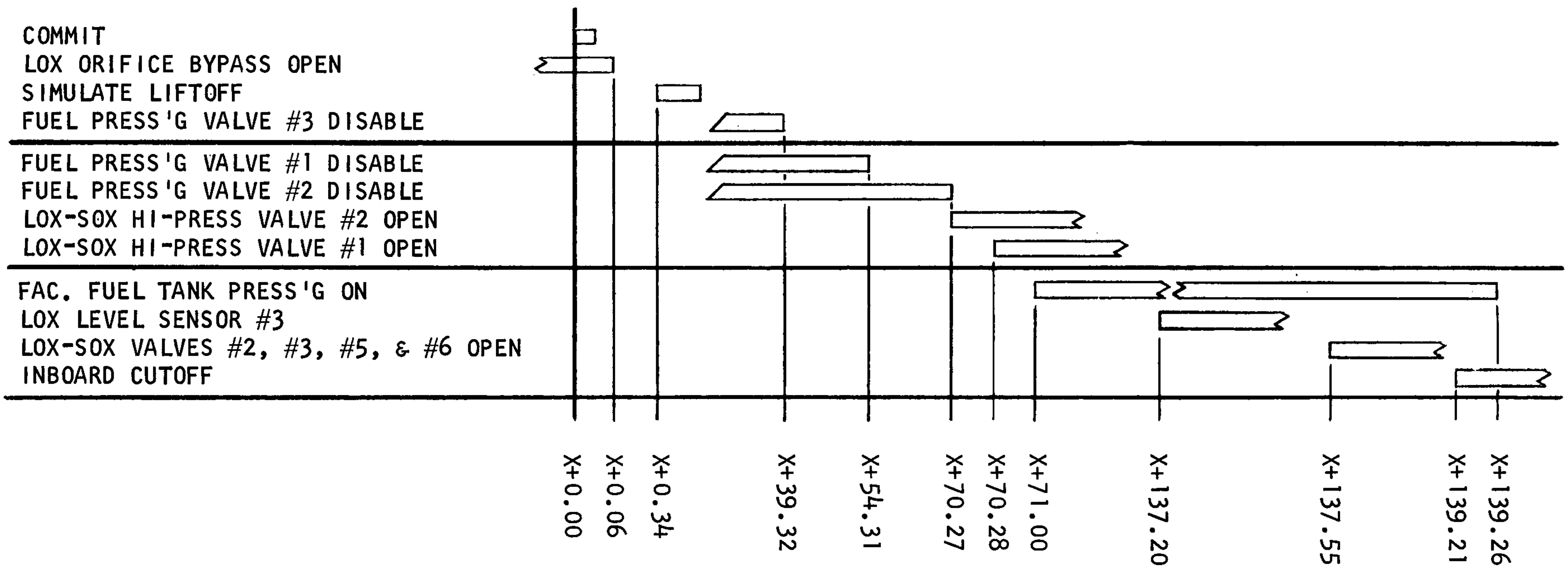
A record of vehicle component operating times while in the Test Laboratory can be found in APPENDIX G.



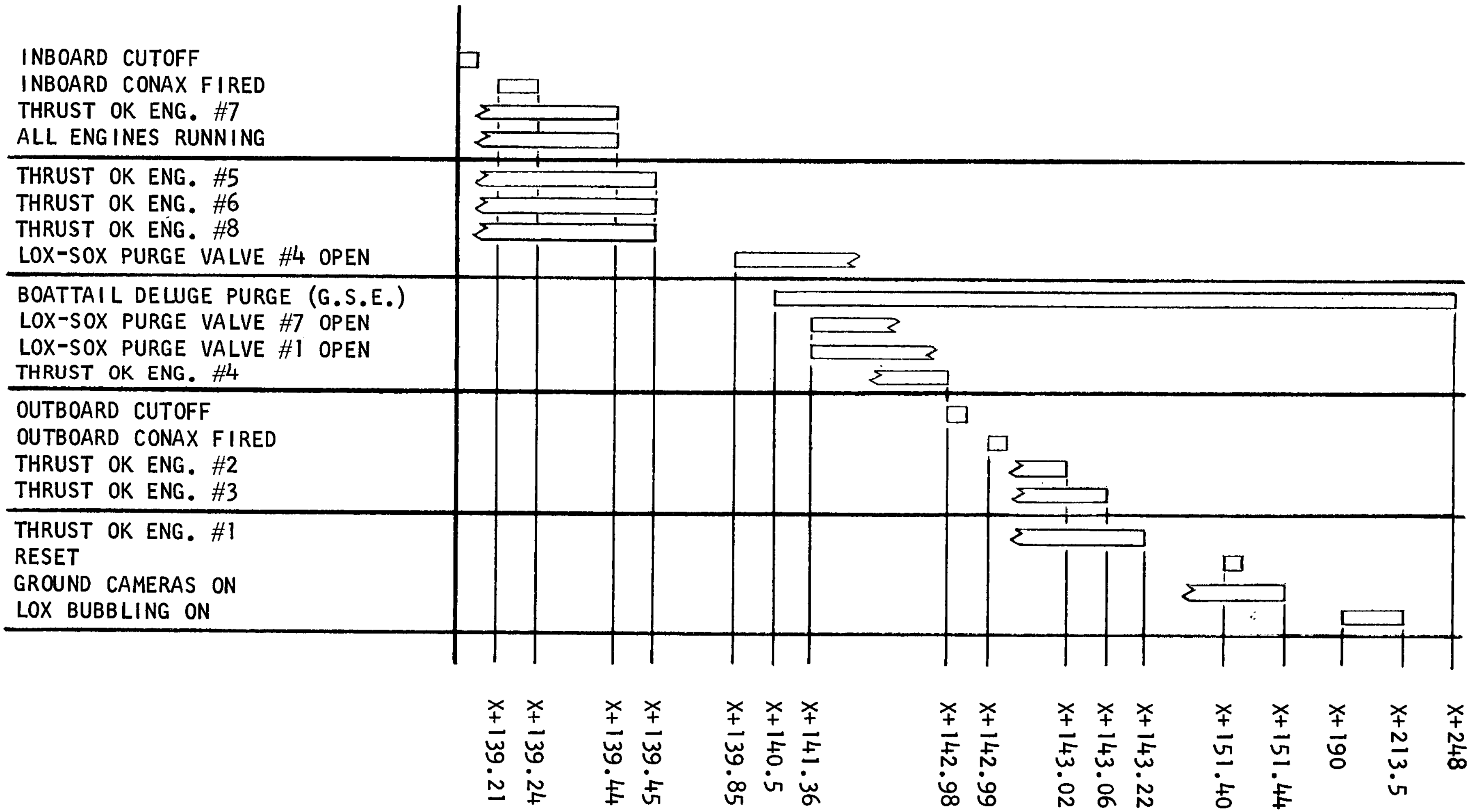
"FIRING COMMAND" TO "IGNITION COMMAND"
FIGURE 7-1



"IGNITION COMMAND" TO "COMMIT"
FIGURE 7-2



"COMMIT" TO "INBOARD CUTOFF"
FIGURE 7-3



"INBOARD CUTOFF" TO "RESET"
FIGURE 7-4

SECTION 8
TELEMETRY SYSTEMS

The telemeter systems operated satisfactorily during both tests with the exceptions of the discrepancies noted in the Preliminary Static Test Report, Tests SA-18 and SA-19. During test SA-18, 97 percent of the telemetered measurements were satisfactory, whereas 92 percent of the measurements operated satisfactorily during test SA-19. The lower percentage of satisfactory data received during test SA-19 is attributable to the malfunction of three Universal Measuring Adapter (UMA) Rack power supplies (50M10363). These three power supplies accounted for 31 of the 58 measurements lost during test SA-19. A post-test failure analysis was conducted on the three discrepant power supplies by the Quality Assurance and Reliability Laboratory. From this analysis the cause of the power supplies failure was determined to be an input diode, type TK21 manufactured by Texas Instruments. In the failure analysis report R-QUAL-AVR-370-64, it is recommended that this diode be removed from all flight components that are subject to shock and/or vibration. Consequently, EO A1140-1, which replaces the discrepant diodes with new ones (type IN 3190 manufactured by Texas Instruments), was issued and is presently being implemented on stage S-I-8.

A specific breakdown of discrepancies according to measurement numbers, measurement names, and telemeter channel is given in the Telemetry Systems Section of the Preliminary Static Test Report for Tests SA-18 and SA-19. All measurements not contained in these discrepancy lists operated satisfactorily.

A comparison of hardwire and telemetry data for combustion chamber pressure, measurements 4.51 and D1, respectively, is tabulated in the Confidential Supplement, tests SA-18 and SA-19. This table indicates that good agreement was obtained between hardwire and telemetered data for these measurements.

SECTION 9
CONCLUSIONS

ENGINE SYSTEMS. The performance of all engines during the final static test, SA-19, is considered acceptable for launch.

The auxiliary LOX dome purge that was added to the inboard engines of stages S-I-9 prior to test SA-18 failed to prevent the LOX domes and injectors on these engines from becoming contaminated with soot. The contamination is caused by blowback which occurs during the interval when the inboard engines have cut off and the outboard engines are continuing to run. The degree of contamination found was approximately the same as that found in the engines of stage S-I-7 which were checked and found to be within the Rocketdyne specification limits. Further study is in process for increasing the effectiveness of the auxiliary LOX dome purge.

The effort to correct random fluctuations recorded from the fuel pump and LOX pump inlet pressure transducers (measurements 52.07 and 52.06, respectively) was not entirely successful. The problem was thought to have been caused by moisture shorting out the connectors. Accordingly, moisture proof connectors were installed at these transducers, but random fluctuations were recorded from LOX pump inlet pressure transducers on engines 2, 4, and 8 during test SA-19. These fluctuations indicate a problem still exists.

The turbopump No. 8 bearing on engines 1, 2, 4, 7, and 8 showed evidence of outer race rotation. This condition has been experienced previously and is not considered detrimental to engine operation.

In order to prevent possible GG LOX injector fuel contamination, seal plate assembly (P/N NA5-26702) and test seal plate (P/N C-SSTB-2024) were installed at the fuel bootstrap line to inlet manifold flange on each engine of stage S-I-9 prior to the stage being removed from STTE. These plates were installed after all possible fuel was drained from the bootstrap line. Similar action will be taken on stage S-I-8. Stage S-I-10 will incorporate specially fabricated seal plates, Rocketdyne P/N 303966. It has been recommended that on Chrysler built stages, the post-static firing checkout of the fuel bootstrap line and gas generator control valve be made while the stage is vertical in the stage test stand, and that further checkout should not be made until the stage is again vertical at Cape Kennedy. This would eliminate the possibility of releasing fuel from the top side of the control valve fuel poppet (while the stage is horizontal) into the conisphere where further handling in the horizontal position could cause GG LOX injector contamination.

During thrust chamber leak checks (using GN_2), slight leakage was observed at the three tapped holes in the LOX dome outer bolt circle on engine 2 (S/N H-5012).

The fragment of safety wire remaining in one of the LOX injector orifices on engine 6 does not present a hazard to engine operation.

Initial high breakaway torques recorded on the turbopump of engine 3 following test SA-18, and on the turbopumps of engines 3, 5, 7, and 8 following test SA-19 returned to normal after the shafts had been rotated. Carbon deposits between the carbon seal and turbine shaft is the probable cause of these initial high breakaway torques.

ENGINE HYDRAULIC SYSTEMS. The engine hydraulic systems operated satisfactorily during static test of stage S-I-9 with all engine hydraulic system static test requirements accomplished as outlined in the gimbal programs for each test.

It has been recommended in UCR 10662, that the yaw actuator differential pressure transducer (measurement 55.62) on engine 2 be repaired or replaced. Post-test investigation revealed that one of the transducer body connections was loose and that moisture was evident in the body connection.

Unsatisfactory Condition Report 10661 recommends that the erratic fluctuations indicated by the supply pressure trace (measurement 56.01) on engine 3 be investigated further when stage S-I-9 returns to Manufacturing Engineering Laboratory. Due to the similarity of previously experienced conditions, the problem is thought to be caused by a faulty transducer.

PROPELLANT AND PNEUMATIC SYSTEMS.

1. LOX System. The LOX system functioned satisfactorily during tests SA-18 and SA-19, although the LOX tank pressure exceeded the specified limits of 50±2.5 psia. During test SA-18, the LOX tank pressure attained a maximum of 54 psia at X+25 seconds. Following ignition on test SA-19, LOX tank pressure fluctuated slightly and stabilized at 54 psia at X+5 seconds. This pressure was maintained until X+33 seconds, after which time it slowly decreased to 49.7 psia at outboard engine cutoff. LOX tank pressure was within the specified limits from approximately X+52 seconds until the conclusion of the test.

The 1.5 psi over-pressurization of the LOX system was due to excessive GOX flow past the closed GFCV gate. The excessive GOX flow was possibly due to incorrect GFCV stop set points, improper LOX-to-heat exchanger orifice sizes, excessive output of the heat exchangers, or a combination of these.

The 3.77 second interval between inboard and outboard cutoff of test SA-19 was less than the anticipated interval, which is approximately 6 seconds, and becomes critical for payloads such as the micrometeoroid satellites. The primary cause for this short time interval has been attributed to a combination of two factors:

a. The LOX low level sensor probe was located to accommodate a 12 inch height differential rather than the 6 inch height differential required on stage S-I-9.

b. The 20.5 inch diameter center LOX tank liquid orifice did not yield the calculated 6 inch height differential.

Further opportunity to check the cutoff transition and propellant utilization will be provided with stage S-I-8, which will be static test fired with properly located probes in conjunction with the re-sized center LOX tank liquid orifice.

2. Prevalve Relief Test. A special prevalve relief test was conducted immediately following test SA-18 cutoff to evaluate the relief capabilities of the reworked prevalves. The prevalves closed at cutoff and were left in the closed position for 15 minutes. Maximum pump inlet pressure recorded was 41.3 psig in the LOX suction line to engine 2. The test indicated that the prevalves were relieving properly.

3. Prevalve Closing Tests. The prevalve closing time differences as recorded during tests SA-18 and SA-19 indicate that extended exposure to cryogenic temperatures affect the prevalve closing times. It is not known whether the LOX prevalves are closing slower at cryogenic temperatures or whether the valve position indicator is not giving a true valve position indication. Also, it has been necessary to remove the LOX prevalve control line orifices on previous stages to improve LOX prevalve closing times.

4. Fuel System. The fuel system functioned satisfactorily during the acceptance test firings.

5. LOX-SOX Disposal System. The LOX-SOX disposal system functioned properly during test SA-19 (the system was not activated during test SA-18).

6. Control Pressure System. The control pressure system functioned satisfactorily during tests SA-18 and SA-19. However, the control spheres pressure decayed to a lesser pressure at cutoff than is normally anticipated. During a full duration test firing, the control spheres pressure (measurement 6.06) normally decays from the initial 3000 psig to approximately 2200 to 2300 psig at outboard engine cutoff signal. During test SA-19, the control spheres pressure decayed to 1600 psig at outboard engine cutoff signal. At the present time, it is not known what caused the excessive control spheres pressure decay rate.

ENGINE COMPARTMENT ENVIRONMENT. The boattail temperatures and turbine spinner surface temperatures were satisfactorily maintained by the boattail heating system during the standby period of each test.

There was no evidence of fire or hot gas leaks in the engine compartment during tests SA-18 and SA-19.

Engine curtain and heat shield damage was negligible during test SA-18. Post-test inspection, following test SA-19, revealed severe damage to the heat shield. However, it was observed from the motion pictures that the loss of M-31 insulation material does not occur until cutoff of the outboard engines. During test SA-19, the Fiberglas heat shield curtain on engine 3 was extensively torn, and the exposed flexible gimbal boot was burned on the surface but not penetrated. The damaged Fiberglas heat shield curtain is a static test item only and had been used during static testing of the last three stages. All engine curtains and heat shield panels will be replaced prior to flight.

VIBRATION AND SPECIAL INSTRUMENTATION. A detailed discussion of the vibration and acoustic measurement data for tests SA-18 and SA-19 is published in the Vibration and Acoustic Evaluation Report dated May 22, 1964. Also included in this report is a discussion of the rough combustion cutoff (RCC) systems.

The fire detection system functioned as required for tests SA-18 and SA-19, and no abnormal temperatures were detected.

Special radiation calorimeters were installed on the test tower to measure the radiant energy of the exhaust plume during test SA-18 and SA-19. Results from these measurements are presented in the PSTR's for tests SA-18 and SA-19.

ELECTRICAL CONTROL SYSTEMS. Saturn stage S-I-9 underwent electrical system verification during prestatic testing and static firings while at Test Laboratory. Electrical problems which occurred on stage S-I-9 were corrected prior to each test. No major problems were encountered during either firing.

<u>TELEMETRY SYSTEMS</u>. The telemeter systems operated satisfactorily during both tests with the exceptions of the discrepancies noted in the Preliminary Static Test Report, Tests SA-18 and SA-19. During test SA-18, 97 percent of the telemetered measurements were satisfactory, whereas 92 percent of the measurements operated satisfactorily during test SA-19. The lower percentage of satisfactory data received during test SA-19 is attributable to the malfunction of three Universal Measuring Adapter Rack power supplies (50M10363). Post-test failure analysis traced the cause of the problem to a faulty input diode. Engineering Order, EO A11140-1, which replaces the discrepant diodes with a new type, was issued and is presently being implemented on stage S-I-8.

Astrionics Laboratory is cognizant of the discrepancies and problem areas encountered on stage S-I-9, and the necessary corrective action will be taken while the stage is located at Manufacturing Engineering Laboratory.

SECTION 10
RECOMMENDATIONS

ENGINE SYSTEMS.

1. Engine Thrust. Thrust of each engine was within specification, and no further reorificing is recommended.

2. Inboard Engines LOX Domes and Injectors Contamination. Since the degree of contamination was approximately the same as that found in the engines of stage S-I-7 which were checked and found to be within specification limits, no corrective action is recommended.

3. Fuel and LOX Pump Inlet Pressure Transducers (Measurements 52.07 and 52.06, Respectively). Random fluctuations recorded from these transducers during tests SA-18 and SA-19 indicate a problem exists and investigation is recommended.

4. Turbopump No. 8 Bearing Outer Race Rotation. No corrective action is recommended.

5. GG LOX Injector Fuel Contamination. It has been recommended that on Chrysler built stages, the post-static firing checkout of the fuel bootstrap line and gas generator control valve be made while the stage is vertical in the static test stand, and that further checkout should not be made until the stage is again vertical at Cape Kennedy.

6. Leakage Observed at Three Tapped Holes in the LOX Dome Outer Bolt Circle, Engine 2. The leakage observed (using GN_2) was slight and no corrective action is recommended.

7. Safety Wire Fragment Remaining in One LOX Injector Orifice, Engine 6. No corrective action is recommended.

8. Turbopump Torques. Since the initial high breakaway torques recorded on the turbopumps of engines 3, 5, 7, and 8 following test SA-19 returned to normal after the shafts had been rotated, no corrective action is recommended.

ENGINE HYDRAULIC SYSTEMS.

1. Yaw Actuator Differential Pressure Transducer (Measurement 55.62), Engine 2. It is recommended in UCR 10662 that this transducer be repaired or replaced.

2. Supply Pressure Trace (Measurement 56.01), Engine 3. Because of erratic fluctuations recorded from this measurement, UCR 10661 recommends that this condition be further investigated when stage S-I-9 is returned to Manufacturing Engineering Laboratory.

PROPELLANT AND PNEUMATIC SYSTEMS.

1. LOX System.

a. LOX System 1.5 psi Over-pressurization. The Propulsion and Vehicle Engineering Laboratory will make the decision as to whether or not any corrective action is warranted.

b. Interval Between Inboard and Outboard Engine Cutoff Signal. The shorter-than-anticipated time interval between inboard and outboard engine cutoff signals will probably be corrected on stage S-I-8 by proper location of the LOX low level sensor probe in conjunction with a resized static test LOX tank liquid orifice. It is recommended that the LOX low level sensor probe on stage S-I-9 be located so as to accommodate the required 6 inch height differential in conjunction with the 17.0 inch flight size LOX tank liquid orifice.

2. Prevalve Closing Times. Since it is not known whether the LOX prevalves are closing slower at cryogenic temperatures or whether the valve position indicator is not giving a true valve position indication, it is recommended that more extensive acceptance and qualification tests be performed and corrective action taken. Also, since it has been necessary to remove the LOX prevalve control orifices on previous stages to improve LOX prevalve closing times, it is further recommended that subsequent stages be delivered to STTE with the LOX prevalve orifices removed.

3. Control Pressure System. To determine why the 750 psi control spheres pressure decayed to a lesser pressure at cutoff than is normally anticipated, it is recommended that further checks of the system be made while the stage is located at Manufacturing Engineering Laboratory.

APPENDIX A

SYSTEMS STATIC TEST PROCEDURES

SYSTEMS STATIC TEST PROCEDURES

The following is a list of the applicable systems static test procedures used by Chrysler Corporation personnel in static testing Saturn stage S-I-9:

Stage Handling and Facility System

Procedure No.	Title
6-CHSI-100	S-I Stage Installation Procedure
6-CHSI-101	Crane-Proof Loading Procedure
6-CHSI-102	Transporter Operation
6-CHSI-103	Transporter Maintenance
6-CHSI-104	Barge Loading and Unloading - S-I Stage
6-CHSI-105	Retainer Rod Adjustment Procedure
6-CHSI-110	Upper and Lower Horizontal Stabilizer Rod Adjustment Procedure
6-CHSI-120	Equalizing Dead Load on Vertical Load Cells Procedure
6-CHSI-125	S-I Stage Alignment Procedure
6-CHSI-130	S-I Stage Removal Procedure
6-CHSI-140	Deflector Checkout Procedure
6-CHSI-145	Firex System Priming Procedure
6-CHSI-150	Firex Panels Checkout Procedure
6-CHSI-155	Boattail Conditioner Operation Procedure
6-CHSI-165	Instrument Compartment Air Conditioning System Operating Procedure

Pneumatic and Propellant Systems

Procedure No.	Title
6-CHSI-200	Tower to Stage Interconnect Procedure
6-CHSI-205	Control System Leak Check
6-CHSI-210	Pressure Switch Functional Checkout
6-CHSI-220	Components Test
6-CHSI-225	GOX Flow Control Valve Checkout
6-CHSI-230	Fuel Transfer
6-CHSI-235	LOX Transfer
6-CHSI-240	Pneumatic System Preparation for Static Firing
6-CHSI-245	Pneumatic Systems Verification of Cleanliness
6-CHSI-250	Pneumatic Systems Securing Procedure
6-CHSI-260	LOX & Fuel System Leak Check
6-CHSI-265	GOX System Leak Check
6-CHSI-270	High Pressure System Leak Check

Propulsion System

Procedure No.	Title
6-CHSI-301	Engine Pressure Switch Functional Checks
6-CHSI-304	Gas Generator and Exhaust System Leak Check
6-CHSI-305	Thrust Chamber Leak Check
6-CHSI-306	Ground Hydraulic Service Unit Operating Procedure
6-CHSI-307	Engine Hydraulic System Preparation
6-CHSI-308	Hydraulic System Calibration and Checkout

Procedure No.	Title
6-CHSI-309	Pretest Gimbal Control and Hydraulic Systems Functional Check
6-CHSI-310	LOX Pump Seal Cavity Contamination Check
6-CHSI-311	Fuel Lube Blowdown
6-CHSI-312	Main Fuel Valve and Ignition Monitor Valve Leakage and Functional Test
6-CHSI-313	Gas Generator Control Valve Functional Test
6-CHSI-314	Fuel Control System Leak Test
6-CHSI-317	Engine Shipping Equipment Removal and Static Test Equipment Installation
6-CHSI-318	Engine Static Test Equipment Removal and Shipping Equipment Installation
6-CHSI-340	Fuel Additive Blending Unit Filling Procedure
6-CHSI-341	Handling and Installation of Hypergolic Igniter
6-CHSI-342	Handling and Installation of Solid Propellant Gas Generators, Initiators and GG Igniters.
6-CHSI-343	Conax Valve Installation
6-CHSI-344	Procedure for Greasing Gimbal Bearings
6-CHSI-345	Thrust Chamber Filling Procedure
6-CHSI-346	Main Fuel Valve Leak Check
6-CHSI-354	Post Static Pyrotechnic Removal
6-CHSI-355	Turbopump Preservation
6-CHSI-356	Removal of Residual Fuel from the Stage
6-CHSI-357	Thrust Chamber Jacket Flushing
6-CHSI-370	LOX Dome Flush and Purge Procedure (Single Engine)
6-CHSI-371	H-1 Engine Change and Checkout
6-CHSI-372	H-1 Engine Removal and Installation Procedure

Electrical Controls

Procedure No.	Title
1-CHSI-407	Vehicle Cable Connections
1-CHSI-408	Routine Removal of Power
1-CHSI-409	Routine Application of Power
1-CHSI-410	Initial Application of Power
1-CHSI-411	Power Transfer Test
1-CHSI-412	Observer Cutoff
1-CHSI-413	Voltage Failure Cutoff
1-CHSI-414	Premature Commit Cutoff
1-CHSI-415	Fire Detection Cutoff
1-CHSI-416	Rough Combustion Cutoff
1-CHSI-417	Sequence Test, Part I
1-CHSI-418	Sequence Test Part II
1-CHSI-419	Sequence Test, Cycle
1-CHSI-420	Sequence Test, Shutdown
1-CHSI-421	Sequence Failure Cutoff
1-CHSI-422	Thrust Failure Cutoff Test
1-CHSI-423	Propellant Level Cutoff
1-CHSI-424	LOX Depletion Cutoff
1-CHSI-425	Ordnance Checkout with Launch Failure Cutoff
1-CHSI-426	Conax Valves Pre-Installation Checkout
1-CHSI-427	Engine Component Heater Check
1-CHSI-428	Electrical Checkout of SPGG Initiators and Initiator Harnesses

Procedure No.	Title
1-CHSI-429	Safety Wiring of Connectors
1-CHSI-430	TSPS Cutoff
5-CHSI-451	SITS Power Up
5-CHSI-452	Booster Hydraulic System Preparation
5-CHSI-453	Control System Calibration
5-CHSI-454	Control Accelerometer Checkout and Calibration
5-CHSI-455	Rate Gyro Checkout and Calibration
5-CHSI-456	Program Device Checkout
5-CHSI-457	Gimbal Programmer Calibration
5-CHSI-458	Gimbal System Dry Run and Functional Checkout
5-CHSI-460	Program Device Propellant Level Cutoff
5-CHSI-461	Engine Interference Check
5-CHSI-462	X-15 Countdown (Gimbal Supplement)
5-CHSI-463	X-15 Countdown (SITS Supplement)
5-CHSI-464	SITS Sequence Test
5-CHSI-465	SITS Cutoff Test
5-CHSI-466	Pre-Static Gimbal Test

R.F. & Telemetry

Procedure No.	Title
3-CHSI-506	Manual Checkout of Temperature Measurements
3-CHSI-510	Manual Checkout of Pressure Measurements
3-CHSI-515	Manual Checkout of Strain Gage Measurements

Procedure No.	Title
3-CHSI-518	Manual Checkout of Vibration Measurements
3-CHSI-520	Dial Code Operations
3-CHSI-525	Telemeter System Calibration
3-CHSI-526	Oscillator Calibration, Eleven Point
3-CHSI-527	Discriminator Calibration
3-CHSI-528	Tape Speed Compensation Adjustment and Recorder Set-Up
3-CHSI-529	T/M Receiver Adjustment
3-CHSI-531	CEC Recording Oscillograph Set-Up
3-CHSI-532	SS Band Ground Station Alignment
3-CHSI-533	PCM Ground Station Alignment
3-CHSI-534	Solid State Decommutator Checkout and Set-Up
3-CHSI-540	Telemetry Monitoring of Liquid Level Measuring System
3-CHSI-550	Test Cable Removal

Instrumentation

Procedure No.	Title
2-CHSI-551	Pressure Transducer Calibration by Application of Pressure
2-CHSI-552	Pressure Transducer Calibration by Simulation
2-CHSI-553	Temperature Calibrations
2-CHSI-554	Strain Gage Calibration, One Active Arm
2-CHSI-555	Strain Gage Calibration, Four Active Arms
2-CHSI-556	Vibration Transducer Calibration

Procedure No.	Title
2-CHSI-557	Rough Combustion Cutoff System Calibration
2-CHSI-558	Displacement Transducer Calibration
2-CHSI-559	Gearcase Vibration Test
2-CHSI-560	Acoustic Transducer Calibration
2-CHSI-561	Commutated Tension Rod Calibration
2-CHSI-562	Standardization of Wiancko Calibrator and Calibration Test Gages

Integrated System Operations

Procedure No.	Title
7-CHSI-601	L-1 Day Countdown Checklist
7-CHSI-602	Firing Day Countdown
7-CHSI-604	Post-Firing Shut Down
7-CHSI-609	Propellant Loading Test
7-CHSI-610	Simulated Flight Test
7-CHSI-611	X-15 Minute Countdown (Short Duration)
7-CHSI-612	X-15 Minute Countdown (Long Duration)

APPENDIX B

REPORTS AND MEMORANDUMS PUBLISHED CONCERNING THE STATIC TESTING OF SATURN STAGE S-I-9

REPORTS AND MEMORANDUMS PUBLISHED CONCERNING THE STATIC TESTING OF SATURN STAGE S-I-9

1. Memo R-P&VE-PA-64-M-104, "S-I Stage LOX Dome Purge Improvement," February 11, 1964.

2. Memo R-TEST-SBT-#6-64, "Minutes of Meeting on Procedure to be Followed to Prevent H-1 Engine Gas Generator Contamination," April 9, 1964.

3. Memo R-P&VE-PA-64-M-447, "Contamination of H-1 Engine Gas Generators," March 31, 1964.

4. Chrysler ICC Memo T-297, "H-1 Engine Gas Generator Contamination," April 27, 1964.

5. Memo R-P&VE-PT-179-63, "Test Requirements for S-I-9 Static Test," December 20, 1963.

6. Memo R-P&VE-PT-121-63, "Static Test Requirements for S-I-9," November 21, 1963.

7. Chrysler ICC Memo T-244, "S-I-9 Propellant Loading and Sub-Systems Test Program Special Tests," March 10, 1964.

8. Memo R-P&VE-VF-234-64, "Transfer of Loaned Property to CCSD," May 15, 1964.

9. Report R-QUAL-AVR-370-64, "Failure of Type TK21 Rectifier During SA-9 Static Firing, Purchased from Transitron Electronic Corp.," April 14, 1964.

10. PSTR, Test SA-18, "Preliminary Static Test Report," March 27, 1964.

11. PSTR, Test SA-18, "Preliminary Static Test Report," April 20, 1964.

12. Report, "Saturn S-I Static Test Plan, Stage S-I-9," January 24, 1964.

13. Report, "Saturn S-I Confidential Supplement, Stage S-I-9," April 20, 1964.

14. Report, "Vibration and Acoustic Evaluation Report," May 21, 1964.

APPENDIX C

REDLINE VALUES FOR STAGE S-I-9

REDLINE VALUES FOR STAGE S-I-9

Values for parameters which will be monitored to assure vehicle safety are specified below. Pre-run checks are made to verify satisfactory engine compartment conditions prior to clearing the stand. Parameters monitored after start of the "automatic countdown" as well as mainstage redline are listed. If any redline value exceeds its tolerance, cutoff shall be initiated unless otherwise specified by special instruction. The person giving cutoff shall indicate over the operating headset channel the reason for cutoff. Blockhouse personnel are warned that the duration test will have the 6-second delayed cutoff and therefore, monitors of the inboard engines should be alerted to expect their parameters to decay prior to cutoff.

PRE-RUN VERIFICATIONS	MAXIMUM	MINIMUM
After LOX tanking has begun, the following parameters will be monitored to assure that the values are not exceeded:		
1. Turbopump Bearing No. 1 Temperature		0° F
2. Oronite Temperature	145° F	105° F
3. Turbine Spinner Surface Temperature	75° F	40° F
PRE-IGNITION		
1. GG LOX Injector Manifold Pressure (Monitor until X-20 minutes)	185 psig	165 psig
2. Turbine Spinner Surface Temperature (Monitor until start of automatic sequencer)	75° F	40° F
*3. Hydraulic Oil Temperature	210° F	40° F
*4. Hydraulic Reservoir Piston Position		18% (360 ohms)
5. Gearcase Pressure	7 psig	2 psig

* Blueline only

		MAXIMUM	MINIMUM
*6.	Turbopump Bearing No. 1 Temperature		0° F
7.	LOX Pump Inlet Temperature (Immediately prior to ignition)	-275° F	-300° F
8.	LOX Pump Inlet Pressure		60 psig
9.	LOX Tank Ullage Pressure	60 psig	
10.	Fuel Pump Inlet Temperature		0° F
11.	Fuel Pump Inlet Pressure		25 psig
12.	Fuel Tank Ullage Pressure	25 psig	
*13.	High Pressure Spheres Pressure	3200 psig	2700 psig
*14.	Control Spheres Pressure	3200 psig	2700 psig

MAINSTAGE

1.	Combustion Chamber Pressure	678 psig	
	NOTE: After mainstage equilibrium has been established, any change in either P_c or GG Temperature must be accompanied by a similar change in the other parameter before cutoff is to be given.		
2.	GG Conisphere Temperature	1400° F Steady State	
	NOTE: After mainstage equilibrium has been established, any change in either P_c or GG Temperature must be accompanied by a similar change in the other parameter before cutoff is to be given.		
*3.	Hydraulic Oil Temperature	275° F	

* Blueline only

		MAXIMUM	MINIMUM
*4.	Hydraulic Reservoir Piston Position		10% (200 ohms)
5.	Gearcase Pressure NOTE: Cutoff to be initiated only if the corresponding pressure switch pick up indication is obtained.	10 psig	
6.	LOX Tank Ullage Pressure	60 psig	
7.	Fuel Tank Ullage Pressure	25 psig	2 psig
8.	Turbopump Bearing No. 1 Lube Jet Pressure (Within 10 seconds after ignition)		75 psig
9.	Turbopump Bearing No. 1 Temperature		0° F
10.	Turbopump Bearing No. 8 Temperature	600° F	
11.	LOX Pump Inlet Pressure NOTE: If the recorder pegs downscale at maximum rate, cutoff shall not be initiated unless the corresponding prevalve closed indication is obtained. For a gradual decrease in pressure below the redline value, cutoff shall be initiated without regard to the prevalve position indicator.		25 psig
**12.	Fuel Pump Inlet Pressure (Facility Fuel Tank Pressurization switch to "ON" at 10 psig) NOTE: If the recorder pegs downscale at maximum rate, cutoff shall not be initiated		5 psig

* Blueline only

** Facility fuel tank pressurizing ON at 10 psig, redline cutoff at 5 psig instead of 10 psig.

	MAXIMUM	MINIMUM
unless the corresponding prevalve closed indication is obtained. For a gradual decrease in pressure below the redline value, cutoff shall be initiated without regard to the prevalve position indicator.		
13. Deflector Water Pressure WP-3 & 4		65 psig
(Cutoff to be initiated only if corresponding pressure switch indication is obtained)		

14. Rough Combustion Cutoff Device

The RCC device shall initiate cutoff after accumulation of 100 msec. equal to or greater than 100 g rms in the frequency range of 960 to 6000 cps.

15. Fire Detection System

The automatic rise rate cutoff device will be set to initiate cutoff if the temperature rise rate is 2.5 MV/sec or greater for a duration of 0.5 second for the flight harness, and 1.0 second for the static test harness.

For observer monitoring, the redline is an increase of five major chart divisions (2.5 MV) in one second.

General instructions for fire detection chart watchers are as follows:

1. If any one fire detection harness pegs upscale - no action.
2. If two or more fire detection harnesses peg upscale - initiate cutoff.
3. If static test LOX or flight harness pegs downscale - no action.
4. If static test fuel harness pegs downscale - initiate cutoff if recorder does not return within five seconds.

APPENDIX D

SATURN ACCEPTANCE TEST MEASURING PROGRAM

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

STAGE S-I-9 TEST NO. SA-19

SHEET 1 OF 3

PROGRAM BASIC EIGHT ENGINES

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
2.01	D18	Pressure Gear Case	Servonic	0-20 psig	Rec.,Msdc.	
2.06	D12	Pressure Fuel Pump Inlet	Giannini	0-100 psig	Rec.,Msdc.	
2.07	D13	Pressure LOX Pump Inlet	Bourns	0-150 psig	Rec.,Msdc.	
2.54	D20	Pressure Lube Oil No. 1 Bearing	Bourns	0-200 psig	Rec.	
4.01		Pressure GG Fuel Injector Manifold	Wiancko	0-1000 psig	Osc.	
4.02		Pressure GG LOX Injector Manifold	Wiancko	0-1000 psig	Rec.,Msdc. Osc.	
4.04		Pressure Turbine Inlet	Wiancko	0-750 psig	Osc.,Msdc.	
4.51		Pressure Combustion Chamber	Wiancko	0-750 psig	Rec.,Msdc. Osc.	
5.51		Pressure Fuel Pump Outlet	Wiancko	0-1500 psig	Osc.,Msdc.	
5.52		Pressure LOX Pump Outlet	Wiancko	0-1000 psig	Osc.,Msdc.	

NOTES

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
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SHEET 2 OF 3

PROGRAM BASIC EIGHT ENGINES

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
13.01-8		Temperature Fuel Pump Inlet	TC-CC	-84.5/150°F	Rec., Msdc.	
13.11		Temperature SPGG Case	TC-CC	-84.5/150°F	Rec.	
14.01	C 1	Temperature LOX Pump Bearing No. 1	TC-IC	-242.7/447.5°F	Rec.,Msdc.	
14.03	XC 89	Temperature Oronite	TC-CA	39/258°F	Rec.	
15.02		Temperature Turbopump No. 2 Bearing	TC-IC	49.2/700.6°F	Msdc.	
15.04		Temperature Turbopump No. 4 Bearing	TC-IC	49.2/700.6°F	Msdc.	
15.08	C6	Temperature Turbopump No. 8 Bearing	TC-IC	-26/640.1°F	Rec.,Msdc.	
16.01		Temperature Conisphere	TC-CA	-83/1665°F	Rec.,Msdc.	
18.01		Temperature Fire Detector Harness	1 Quad CA	-27.5/638.5°F	Rec.,Msdc.	
18.05		Temperature Fire Detector Harness	8 Element CA	2.8/335.7°F	Rec.,Msdc.	
19.01	C 54	Temperature LOX Pump Inlet	R. B.	-300/270°F	Rec.,Msdc.	*
FH114	XC114	Temperature Fire Detector Harness	8 Element CA	2.8/335.7°F	Rec.	
FH115	XC115	Temperature Fire Detector Harness	8 Element CA	2.8/335.7°F	Rec.	
FH116	XC116	Temperature Fire Detector Harness	8 Element CA	2.8/335.7°F	Rec.	
FH117	XC117	Temperature Fire Detector Harness	8 Element CA	2.8/335.7°F	Rec.	

NOTES
*Resistance Bulb - R. B.

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
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PROGRAM BASIC EIGHT ENGINES

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
52.06		Pressure Fuel Pump Inlet	Dynisco	0-200 psig	Osc.	
52.07		Pressure LOX Pump Inlet	Dynisco	0-200 psig	Osc.	
54.51		Pressure Combustion Chamber	Wiancko	0-750 psig	Osc.,Msdc.	*
66.01		Temperature Conisphere	TC-CA	-83/1665°F	Osc.	
92.01	A12	RPM Turbopump	Tachometer	0-7000 rpm	Osc.,Msdc.	
93.01		Position MLV Continuous	Potentio-meter	Open-Close	Osc.	
93.02		Position MFV Continuous	Potentio-meter	Open-Close	Osc.	
96.01		Ignition			Osc.	**
96.03		Hypergol Detector			Osc.	**
96.04		Conax No. 1			Osc.	**
96.04A		Conax No. 2			Osc.	**
96.09		Master Cutoff Relay Outboard			Osc.	**
96.11		Thrust OK Switch			Osc.	**
96.21		Liftoff			Osc.	**
96.44		Gear Case Pressure Switch		On-Off	Rec.	***

NOTES *Record on two Osc: Engine 1-8 Chamber Pressure
**These measurements taken from networks within Blockhouse
***Indicating light at recorder for measurement 2.01

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

STAGE S-I-9 TEST NO. SA-19

SHEET 1 OF 2

PROGRAM BASIC PROPELLANT TANKS

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
2.04-3	D2-F3	Pressure Fuel Tank No. 3	Edcliff	0-30 psig	Rec.,Msdc.	
2.05-1	D3-01	Pressure LOX Tank No. 1	Giannini	0-100 psig	Rec.,Msdc.	
2.05-C	D3-0C	Pressure LOX Tank (Center)	Giannini	0-100 psig	Rec.,Msdc.	
2.11		Delta Pressure Fuel Tank No. 3	Wiancko	0-20 psid	Rec.	
2.17		Delta Pressure LOX Tank No. 3	Wiancko	0-30 psid	Rec.	
5.65	D41-9	Pressure 750 Regulator	Bourns	0-800 psig	Rec.,Msdc.	
6.03	D139-11	Pressure Gas High Pressure Spheres	Edcliff	0-3500 psig	Rec.,Msdc.	
6.06	D40-9	Pressure Control Spheres Supply	Edcliff	0-3500 psig	Rec.,Msdc.	
13.97		Temperature Ambient Air Center Tail Skirt	TC-CC	-84.5/150°F	Rec.	
45.011		Thrust Vertical Cell No. 1	Load Cell	+/-200 Kips	Msdc.,Osc.	
45.012		Thrust Vertical Cell No. 2	Load Cell	+/-200 Kips	Msdc.,Osc.	
45.013		Thrust Vertical Cell No. 3	Load Cell	+/-200 Kips	Msdc.,Osc.	
45.014		Thrust Vertical Cell No. 4	Load Cell	+/-200 Kips	Msdc.,Osc.	
45.015		Thrust Vertical Cell No. 5	Load Cell	+/-200 Kips	Msdc.,Osc.	

NOTES

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
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SHEET 2 OF 2
PROGRAM
BASIC PROPELLANT TANKS

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
45.016		Thrust Vertical Cell No. 6	Load Cell	+/-200 Kips	Msdc.,Osc.	
45.017		Thrust Vertical Cell No. 7	Load Cell	+/-200 Kips	Msdc.,Osc.	
45.018		Thrust Vertical Cell No. 8	Load Cell	+/-200 Kips	Msdc.,Osc.	
45.03		Thrust Lateral Cell A	Load Cell	+/-50 Kips	Osc.	
45.031		Thrust Lateral Cell B	Load Cell	+/-50 Kips	Osc.	
45.032		Thrust Lateral Cell C	Load Cell	+/-50 Kips	Osc.	
45.033		Thrust Lateral Cell D	Load Cell	+/-50 Kips	Osc.	
45.041-45.048		Tension Rod (Lower)	Strain Gage	100 Kips	Rec.	Commutate
13.322		Temperature C Ambient Air Instrument Compartment Above F-1	TC-CC TC-CC	-84.5/150°F	Rec.	
13.326		Temperature C Ambient Air Instrument Compartment Above F-2	TC-CC	-84.5/150°F	Rec.	
13.33		Temperature Inlet Air Supply	TC-CC	-84.5/150°F	Rec.	
P2		Pressure 1 Cubic Foot Sphere	Wiancko	0-3500 psig	Rec.	*
P3		Pressure GN_2 Manifold	Wiancko	0-3500 psig	Rec.	*
43.49A	K72-9	Pos. GOX Control Valve	Potentio-meter	Open-Close	Rec.,Msdc.	**

NOTES * LOX/SOX System
** Heat Exchanger

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
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STAGE S-I-9 TEST NO. SA-19

SHEET 1 OF 2

PROGRAM

ADDITION TO PROPELLANT TANK PROGRAM

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
2.231-3		Delta Pressure LOX Residual Tank No. 3	Wiancko	0-5 psid	Rec.,Msdc.	
2.231-C		Delta Pressure LOX Residual Center Tank	Wiancko	0-5 psid	Rec.,Msdc.	
13.43		Temperature Compartment Ambient Air, Station 170, Below LOX 4 Approximately 6" from Inner Skin	TC-CC	-84.5/150°F	Rec.	
13.44		Temperature Compartment Ambient Air, Station 130, Below LOX 4 Approximately 6" from Inner Skin	TC-CC	-84.5/150°F	Rec.	
13.45		Temperature Outer Skin, Below LOX 4, Station 130	TC-CC	-84.5/150°F	Rec.	
3.61		Delta Pressure GOX Flow Control Valve Bellows	Wiancko	±300 psid	Rec.,Msdc.	
3.63		GOX Flow Control Valve Bias Regulator	Wiancko	0-500 psig	Rec.,Msdc.	
12.14		Temperature 7" LOX Vent Valve	TC-IC	-242.7/150°F	Rec.	
84.38		Lower GOX Line at Outlet Upper Flange, Longitudinal	Cubic	50 g rms	Tape	
84.381		Lower GOX Line at Outlet Upper Flange, Lateral	Cubic	100 g rms	Tape	
84.39		Lower 4" GOX Line Inlet Lower Flange Longitudinal	Cubic	50 g rms	Tape	

NOTES

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

STAGE S-I-9 TEST NO. SA-19

SHEET 2 OF 2
PROGRAM
ADDITION TO PROPELLANT TANK PROGRAM

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
84.391		Lower 4" GOX Line Inlet Lower Flange Lateral	Cubic	100 g rms	Tape	
84.99		GOX Line Downstream of GOX Control Valve Perpendicular to Flow	Cubic	200 g rms	Tape	
84.991		GOX Line Downstream of GOX Control Valve Parallel to Flow	Cubic	200 g rms	Tape	
4.55-8		Pressure Purge Connect Panel	Wiancko	0-300 psig	Osc.	
KA124		Aux. Inb'd LOX Dome Purge Solenoid Act.				

NOTES

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

STAGE S-I-9 TEST NO. SA-19

SHEET 1 OF 1

PROGRAM

BASIC FACILITY MEASURING PROGRAM

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
WP-3		Pressure 30 Inch Supply at Deflector Loop	Wiancko	0-200 psig	Rec.,Msdc.	
WP-4		Pressure 20 Inch Supply at Deflector Loop	Wiancko	0-200 psig	Rec.,Msdc.	
WP-25		Pressure Deluge	Wiancko	0-200 psig	Rec.,Msdc.	
6.02		Pressure GN_2 Supply	Wiancko	0-3500 psig	Rec.,Msdc.	
6.14		Pressure Helium Supply	Giannini	0-3500 psig	Rec.	*
6.51		Pressure Battery GN_2 Supply	Giannini	0-5000 psig		*
11.28		Temperature Air At Tower	TC-CC	-84.5/150°F		**
TM-1		Temperature Manifold Fin I	TC-CC	-84.5/337.8°F		**
LFED 1		Position Fuel Emergency Dump	Potentiometer	0-100 percent		*

NOTES * Remote Indicator
** Electrical Indicator

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

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SHEET 1 OF 1

PROGRAM

ADDITION NO. 1 TO FACILITY PROGRAM

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
C-66		Total Calorimeter Test Fixture $3\frac{1}{2}$ Level Mounted on Insulated I Beam	Chrysler	0-40 BTU/ft^{2}sec	Rec.	
C-67		Radiation Calorimeter Test Fixture $3\frac{1}{2}$ Level Mounted on Insulated I Beam	Chrysler	0-40 BTU/ft^{2}sec	Rec.	
16.41		Temperature Test Fixture TC-1	TC-CA	39/911^{o}F	Msdc.	
16.42		Temperature Test Fixture TC-2	TC-CA	39/911^{o}F	Msdc.	
16.43		Temperature Test Fixture TC-3	TC-CA	39/911^{o}F	Msdc.	
16.44		Temperature Test Fixture TC-4	TC-CA	39/911^{o}F	Msdc.	
C-74		Radiation Calorimeter Parallel to Engine 8 Flame Plume 24 Inches Below Nozzle Exit	HTL-6LV	0-136 BTU/ft^{2}sec	Rec.	
C-75		Radiation Calorimeter Parallel to Engine 8 Flame Plume 48 Inches Below Nozzle Exit	HTL-6LV	0-168 BTU/ft^{2}sec	Rec.	
C-76		Radiation Calorimeter Parallel to Engine 8 Flame Plume 96 Inches Below Nozzle Exit	HTL-6LV	0-159 BTU/ft^{2}sec	Rec.	

NOTES

DATE APPROVED January 20, 1964

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

SHEET 1 OF 1

STAGE S-I-9 TEST NO. SA-19

PROGRAM: BASIC GIMBALING PROGRAM*

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
14.07	C59	Temperature Hydraulic Oil	TC-IC	-26/315.5°F	Rec.	
43.39	XG8	Position Hydraulic Piston	Potentiometer	0-100 percent	Rec.	
55.62	D30	Delta Pressure Yaw Actuator	Statham	±3000 psid	Osc.	
55.63	D31	Delta Pressure Pitch Actuator	Statham	±3000 psid	Osc.	
56.01	D29	Pressure Hydraulic Oil Supply	Edcliff	0-3500 psig	Osc.	
93.05		Position Pitch Actuator (Bp)			Osc.	**
93.06		Position Yaw Actuator (By)			Osc.	**
96.05		Input Signal Pitch (Θp)			Osc.	**
96.06		Input Signal Yaw (Θy)			Osc.	**
96.07		Control Valve Pitch (Ip)			Osc.	**
96.08		Control Valve Yaw (Iy)			Osc.	**

NOTES * All measurements made on engines 1,2,3, & 4.
** These measurements taken from control within Blockhouse.

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

STAGE S-I-9 TEST NO. SA-19

SHEET 1 OF 1

PROGRAM

RATE GYRO PROGRAM

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
92.05		Pitch Control Accelerometer		±5 Meters/ $sec.^2$	Osc.	
92.051		Yaw Control Accelerometer		±5 Meters/ $sec.^2$	Osc.	
92.04		Pitch Rate Gyro Aft Package		±5 deg./sec.	Osc.	
92.041		Yaw Rate Gyro Aft Package		±5 deg./sec.	Osc.	
92.042		Roll Rate Gyro Aft Package		±5 deg./sec.	Osc.	

NOTES
All measurements taken from control within Blockhouse.

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

SHEET 1 OF 1

PROGRAM

HEAT SHIELD PROGRAM

STAGE S-I-9 TEST NO. SA-19

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
2.733		Pressure Heat Shield Between Engines 3 & 4	Wiancko	0-5 psig	Osc.	*
16.233		Temperature Gas Probe 1/16 inch from Surface, Radiation Shielded	TC-CA	39/911°F	Msdc.	
16.234		Temperature Gas Probe 1/16 inch from Surface	TC-CA	39/911°F	Msdc.	
16.40A		Temperature Heat Sink C-54	TC-CA	39/258°F	Msdc.	
16.40B		Temperature Gas C-54	TC-CA	39/911°F	Msdc.	
16.40C		Temperature Base Plate C-54	TC-CA	39/258°F	Msdc.	
C-54		Total Calorimeter Fin Line IV	Chrysler	0-40 BTU/ft^2sec	Rec.	
C-55		Radiation Calorimeter Fin Line IV	Chrysler	0-25 BTU/ft^2sec	Rec.	

NOTES * Oscillograph Range 10-20 psia

DATE APPROVED December 13, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
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SHEET 1 OF 1

PROGRAM

BASIC VIBRATION PROGRAM

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
81.04		Rough Combustion Cutoff	Endevco	100 g rms 2500 cps	Osc., RCC	
81.041		Emergency Rough Combustion Cutoff	Cubic	50 g rms	Tape	
82.03A		Gear Case Longitudinal (Fuel Side)	Glennite	100 g rms	Tape	
82.03D		Gear Case Longitudinal (LOX Side)	Glennite	100 g rms	Tape	
86.05		Load Platform Center, North-South	Statham	+10 g rms	Osc.	
86.07		Overhead Crane Structure Near Pit End	Statham	±10 g rms	Osc.	
86.09		Crane Support Column, North-South	Statham	±10 g rms	Osc.	
86.20		Overhead Crane Structure Between Tower and Column	Statham	±10 g rms	Osc.	

NOTES

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

STAGE S-I-9   TEST NO. SA-19

SHEET 1 OF 6

PROGRAM

ADDITION NO. 1 TO BASIC VIBRATION PROGRAM

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
81.300-4		Center of Engine 4 Shear Beam at Engine Thrust Post Longitudinal	Cubic	30 g rms	Tape	
81.301-4		Center of Engine 4 Shear Beam at Engine Thrust Post Perpendicular	Cubic	30 g rms	Tape	
81.302-4		Center of Engine 4 Shear Beam at Engine Thrust Post Parallel	Cubic	30 g rms	Tape	
81.303-4		Center of Engine 4 Shear Beam on Unbraced Shear Panel, Longitudinal	Cubic	50 g rms	Tape	
81.304-4		Center of Engine 4 Shear Beam on Unbraced Shear Panel, Perpendicular	Cubic	50 g rms	Tape	
81.305-4		Center of Engine 4 Shear Beam on Unbraced Shear Panel, Parallel	Cubic	50 g rms	Tape	
81.306-8		Center of Engine 8 Shear Beam on Stiffening Members, Longitudinal	Cubic	40 g rms	Tape	
81.307-8		Center of Engine 8 Shear Beam on Stiffening Members, Perpendicular	Cubic	40 g rms	Tape	
81.308-8		Center of Engine 8 Shear Beam on Stiffening Members Parallel	Cubic	40 g rms	Tape	
81.309-8		Center of Engine 8 Shear Beam on Unbraced Panel, Longitudinal	Cubic	50 g rms	Tape	

NOTES

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
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STAGE S-I-9 TEST NO. SA-19

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PROGRAM

ADDITION NO. 1 TO BASIC VIBRATION PROGRAM

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
81.310-8		Center of Engine 8 Shear Beam on Unbraced Panel, Perpendicular	Cubic	50 g rms	Tape	
81.311-8		Center of Engine 8 Shear Beam on Unbraced Panel, Parallel	Cubic	50 g rms	Tape	
84.001-3		Upper Bulkhead of F3, Adjacent to Manhold Cover Perpendicular to Mounting Surface	Statham	5 g rms	Tape	
84.001A-3		Upper Bulkhead of F3, Adjacent to Manhold Cover Perpendicular to Mounting Surface	Cubic	20 g rms	Tape	
84.002-3		Upper Bulkhead of F3, Adjacent to Manhold Cover Parallel to Mounting Surface	Statham	5 g rms	Tape	
84.002A-3		Upper Bulkhead of F3, Adjacent to Manhole Cover Parallel to Mounting Surface	Cubic	10 g rms	Tape	
84.003-4		Upper Bulkhead of F4, Adjacent to Manhole Cover Perpendicular to Mounting Surface	Statham	5 g rms	Tape	
84.003A-4		Upper Bulkhead of F4, Adjacent to Manhole Cover Perpendicular to Mounting Surface	Cubic	20 g rms	Tape	
84.004-4		Upper Bulkhead of F4, Adjacent to Manhole Cover Parallel to Mounting Surface	Statham	5 g rms	Tape	
84.004A-4		Upper Bulkhead of F4, Adjacent to Manhole Cover Parallel to Mounting Surface	Cubic	10 g rms	Tape	

NOTES

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

STAGE S-I-9 TEST NO. SA-19

SHEET 3 OF 6

PROGRAM

ADDITION NO. 1 TO BASIC VIBRATION PROGRAM

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
84.005-3		Juncture of Lower Bulkhead and Sump on F3, Perpendicular to Mounting Surface	Statham	5 g rms	Tape	
84.005A-3		Juncture of Lower Bulkhead and Sump on F3 Perpendicular to Mounting Surface	Cubic	5 g rms	Tape	
84.006-3		Juncture of Lower Bulkhead and Sump on F3, Parallel to Mounting Surface	Statham	5 g rms	Tape	
84.006A-3		Juncture of Lower Bulkhead and Sump on F3, Parallel to Mounting Surface	Cubic	10 g rms	Tape	
84.007-3		Sump of Lower Bulkhead of F3 at Fuel Interconnect Line Flange Longitudinal to Sump	Cubic	10 g rms	Tape	
84.008-3		Sump of Lower Bulkhead of F3 at Fuel Interconnect Line Flange Perpendicular to Sump	Cubic	10 g rms	Tape	
84.009-4		Sump of Lower Bulkhead of F4 at Fuel Interconnect Line Flange, Longitudinal to Sump	Cubic	10 g rms	Tape	
84.0011		Skin of Tank or Skirt $22\frac{1}{2}^{o}$ off Fin I Toward Fin II, Station 54 Perpendicular to Skin	Cubic	80 g rms	Tape	

NOTES

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

STAGE S-I-9 TEST NO. SA-19

SHEET 4 OF 6

PROGRAM

ADDITION NO. 1 TO BASIC VIBRATION PROGRAM

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
84.0012		Skin of Tank or Skirt $22\frac{1}{2}^{\circ}$ off Fin I Toward Fin II, Station 89 Perpendicular to Skin	Cubic	40 g rms	Tape	
84.0013		Skin of Tank or Skirt $22\frac{1}{2}^{\circ}$ off Fin I Toward Fin II, Station 152 Perpendicular to Skin.	Cubic	60 g rms	Tape	
84.0014		Skin to Tank or Skirt $22\frac{1}{2}^{\circ}$ off Fin I Toward Fin II, Station 263 Perpendicular to Skin	Cubic	40 g rms	Tape	
84.0015		Fin Line IV Spider Beam Near Tank Attach Point, Pitch	Glennite	20 g rms	Tape	
84.0016		Fin Line IV Spider Beam Near Tank Attach Point Yaw	Glennite	20 g rms	Tape	
84.0017		Fin Line IV Spider Beam Near Tank Attach Point, Longitudinal	Glennite	20 g rms	Tape	
84.0018-1		Centerline on Bottom of F-1 Lower Bulkhead, Longitudinal	Statham	1 g rms	Tape	
84.0019-1		Skin of F1, Radial at Approximate 60 inches Above Lower Bulkhead Intersection	Statham	1 g rms	Tape	

NOTES

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

STAGE S-I-9 TEST NO. SA-19

SHEET 5 OF 6

PROGRAM

ADDITION NO. 1 TO BASIC VIBRATION PROGRAM

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
84.0023		Near Center of Spider Beam, Top Longitudinal	Statham	1 g rms	Tape	
84.0024-4		Sump of Lower Bulkhead of F4 at Fuel Interconnect Line Flange Perpendicular	Cubic	10 g rms	Tape	
84.0026-4		Unbraced Panel of F4, Station 567 Perpendicular to Skin	Cubic	40 g rms	Tape	
84.0027-4		Unbraced Panel to F4, Station 859 Perpendicular to Skin	Cubic	40 g rms	Tape	
84.999		Input to GOX Flow Control Valve Perpendicular to Flow	Cubic	150 g rms	Tape	
84.9991		Input to GOX Flow Control Valve Parallel to Flow	Cubic	150 g rms	Tape	
97.314-1		F-1, $22\frac{1}{2}^{\circ}$ off Fin I Toward Fin II Station 54	Mike	165 db	Tape	
97.315-1		F-1, $22\frac{1}{2}^{\circ}$ off Fin I Toward Fin II Station 89	Mike	160 db	Tape	
97.316-1		F-1, $22\frac{1}{2}^{\circ}$ off Fin I Toward Fin II Station 152	Mike	155 db	Tape	
97.317-1		F-1, $22\frac{1}{2}^{\circ}$ off Fin I Toward Fin II Station 263	Mike	150 db	Tape	

NOTES

DATE APPROVED December 2, 1963

SATURN ACCEPTANCE TEST MEASURING PROGRAM
NASA MARSHALL
TEST DIVISION

STAGE S-I-9 TEST NO. SA-19

SHEET 6 OF 6

PROGRAM

ADDITION NO. 1 TO BASIC VIBRATION PROGRAM

MEASUREMENT			TRANSDUCERS		RECORDING	REMARKS
STATIC NO.	FLIGHT NO.	DESCRIPTION	NAME	CAL. RANGE	INSTR.	
97.318-4		F-4, $22\frac{1}{2}^{\circ}$ off Fin IV Station 567	Mike	160 db	Tape	
97.319-4		F-4, $22\frac{1}{2}^{\circ}$ off Fin IV Station 859	Mike	160 db	Tape	

NOTES

DATE APPROVED December 2, 1963

APPENDIX E

TEST DATA SHEET
STAGE S-1-9

TEST DATA SHEET
STAGE S-I-9

1. TEST NUMBER................................. SA-18

2. TIME AND DATE.......16:34:50.49.............. March 13, 1964

3. DURATION (reference from ignition command signal to inboard engine cutoff signal)...... 35.22 Seconds

4. ENGINE NUMBERS:

Position No. 1	Position No. 2	Position No. 3	Position No. 4
H-5023	H-5012	H-5025	H-5026
Position No. 5	**Position No. 6**	**Position No. 7**	**Position No. 8**
H-2020	H-2022	H-2023	H-2024

5. TEST OBJECTIVES:

   a. Verification of airborne/ground control systems compatibility.
   b. Determine propellant tank draining rates.
   c. Check of engine calibration with Rocketdyne-delivered GG LOX orifices installed.
   d. Check performance of gimbal control system.
   e. Reliability and performance of telemetry equipment.

6. TEST CONDITIONS:

   a. Cutoff initiated by firing panel operator.
   b. Flight type heat shields and curtains used.

7. STAGE PRESSURE SWITCHES AND RELIEF VALVE SETTINGS:

   a. LOX Tank Pressure Switch................ 45.0 psig
   b. LOX Tank Relief Valve #1 and Emergency Vent Switch............................ 53.2 psig
   c. Fuel Tank Pressure Switch.............. 16.85 psig
   d. Fuel Tank Pressurizing Spheres Switch... 2930 psig
   e. Control Spheres Switch................. 2930 psig
   f. Engine Control Pressure OK Switch....... 625±25 psig
   g. Thrust OK Pressure Switch.............. 810±1% psia
   h. LOX Relief Valves No. 1 & 2 (Relief Setting)............................... 58.0 psig
   i. Fuel Vent Valves No. 1 & 2 (Relief Setting)............................... 19.0 psig

j.	Fuel Tank Safety Valve (Relief Setting).	23.0±1.0	psig
k.	Stage Helium...........................	2870	psig

8. GROUND SUPPORT PRESSURE SWITCHES:

a.	Fuel Bubbling (GN_2)....................	110±15	psig
b.	LOX Bubbling (Helium)....................	315±15	psig
c.	LOX Dome Purge..........................	195±15	psig
d.	GG LOX Injector Purge..................	270±15	psig
e.	Fuel Injector Purge....................	375±15	psig
f.	Turbine Spinner (Facility Safety Switch)	40±10	psig
g.	Gearcase................................	12	psig
h.	Facility Helium.........................	3000±50	psig
i.	Facility GN_2..........................	3000±50	psig

9. TANKAGE AND PURGE ORIFICES:

a.	Ground LOX Pressurizing (Helium).....(1)	0.149	in. dia
b.	LOX Tank Facility Pressurizing (GN_2)...............................(2)	0.386	in. dia
c.	Fuel Tank Pressurizing (GN_2).........(3)	0.238	in. dia
d.	Fuel Tank Auxiliary Pressurizing (GN_2)...............................	None	in. dia
e.	Fuel Sphere Supply..................(1)	0.200	in. dia
f.	Control Spheres Supply..............(1)	0.063	in. dia
g.	Fuel Bubbling.......................(8)	0.018	in. dia
h.	LOX Bubbling........................(8)	0.102	in. dia
i.	Fuel Jacket Fill Line...............(1)	0.189	in. dia
j.	Ground LOX Bypass Orifice...........(1)	0.310	in. dia
k.	105-inch LOX Tank Sump..............(1)	17.0	in. dia

10. REGULATOR PRESSURES:

a.	LOX Dome Purge..........................	250	psig
b.	GG LOX Purge............................	300	psig
c.	Fuel Injector Purge....................	490	psig
d.	LOX Bubbling............................	392	psig
e.	Fuel Bubbling...........................	140	psig
f.	LOX Dome Purge Bypass...................	250	psig
g.	Auxiliary Inboard LOX Dome Purge........	650	psig

11. ENGINE DATA:

TEST SA-18

		ENGINE ORIFICES (INCHES DIAMETER)								
ENGINE	ENGINE NUMBER	GG LOX	GG FUEL	TURBINE SPINNER	MFV	MAIN LOX	MAIN FUEL	MLV	LOX TO H.E.	ENGINE ACCUMULATED TIME (Seconds)
1	H-5023	0.311	0.600	0.870	0.073	None	2.650	0.116	0.102 (3)	447.3
2	H-5012	0.314	0.576	0.870	0.073	None	2.834	0.116	0.102 (3)	235.4
3	H-5025	0.316	0.600	0.870	0.073	None	2.908	0.116	0.102 (3)	367.2
4	H-5026	0.320	0.600	0.870	0.073	None	2.700	0.116	0.102 (3)	251.0
5	H-2020	0.331	0.652	0.870	0.073	None	2.672	0.116	0.102 (3)	342.4
6	H-2022	0.321	0.600	0.870	0.073	None	2.740	0.116	0.102 (3)	416.3
7	H-2023	0.313	0.600	0.870	0.073	None	2.821	0.116	0.102 (3)	283.8
8	H-2024	0.311	0.600	0.870	0.073	None	3.067	0.116	0.102 (3)	325.7

* Time through test SA-18, measured from Pc reaches 90% to Pc decays to 90%.

TEST DATA SHEET
STAGE S-I-9

1. TEST NUMBER.................................. SA-19

2. TIME AND DATE......13:35:32.59 CST........... March 24, 1964

3. DURATION (referenced from ignition command signal to inboard engine cutoff signal)...... 142.21 Seconds

4. ENGINE NUMBERS:

Position No. 1 H-5023	Position No. 2 H-5012	Position No. 3 H-5025	Position No. 4 H-5026
Position No. 5 H-2020	Position No. 6 H-2022	Position No. 7 H-2023	Position No. 8 H-2024

5. TEST OBJECTIVES:

   a. Verification of airborne/ground control systems compatibility.
   b. Determine propellant tank draining rates.
   c. Check performance of gimbal control system.
   d. Reliability and performance of telemetry equipment.
   e. Full duration firing with flight sequence cutoff utilizing LOX low level cutoff sensors.

6. TEST CONDITIONS:

   a. Cutoff initiated by LOX cutoff sensor.
   b. LOX loaded to 550 inches to ensure LOX depletion cutoff.
   c. Flight type heat shields and curtains used.

7. STAGE PRESSURE SWITCHES AND RELIEF VALVE SETTINGS:

   a. LOX Tank Pressure Switch................. 59.4 psia
   b. LOX Tank Relief Valve #1 and Emergency Vent Switch............................. 67 psia
   c. Fuel Tank Pressure Switch................ 16.7 psig
   d. Fuel Tank Pressurizing Spheres Switch.... 2865 psig
   e. Control Spheres Switch................... 2865 psig
   f. Engine Control Pressure OK Switch........ 625±25 psig
   g. Thrust OK Pressure Switch................ 810±1% psia
   h. LOX Relief Valves No. 1 & 2 (Relief Setting).................................. 72.4 psia
   i. Fuel Vent Valves No. 1 & 2 (Relief Setting).................................. 19.0 psig

j.	Fuel Tank Safety Valve (Relief Setting)..	23.0±1.0	psig
k.	Stage Helium............................	2805	psig

8. GROUND SUPPORT PRESSURE SWITCHES:

a.	Fuel Bubbling (GN_2)......................	110±15	psig
b.	LOX Bubbling (Helium)....................	315±15	psig
c.	LOX Dome Purge..........................	195±15	psig
d.	GG LOX Injector Purge...................	270±15	psig
e.	Fuel Injector Purge.....................	375±15	psig
f.	Turbine Spinner (Facility Safety Switch).	40±10	psig
g.	Gearcase................................	12	psig
h.	Facility Helium.........................	3000±50	psig
i.	Facility GN_2.............................	3000±50	psig

9. TANKAGE AND PURGE ORIFICES:

a.	Ground LOX Pressurizing (Helium)......(1)	0.149	in. dia
b.	LOX Tank Facility Pressurizing (GN_2)................................(2)	0.386	in. dia
c.	Fuel Tank Pressurizing (GN_2)..........(3)	0.238	in. dia
d.	Fuel Tank Auxiliary Pressurizing (GN_2)................................	None	in. dia
e.	Fuel Sphere Supply...................(1)	0.200	in. dia
f.	Control Spheres Supply...............(1)	0.063	in. dia
g.	Fuel Bubbling........................(8)	0.018	in. dia
h.	LOX Bubbling.........................(8)	0.102	in. dia
i.	Fuel Jacket Fill Line................(1)	0.189	in. dia
j.	Ground LOX Bypass Orifice............(1)	0.310	in. dia
k.	105-inch LOX Tank Sump...............(1)	20.5	in. dia

10. REGULATOR PRESSURES:

a.	LOX Dome Purge..........................	250	psig
b.	GG LOX Purge............................	300	psig
c.	Fuel Injector Purge.....................	490	psig
d.	LOX Bubbling............................	392	psig
e.	Fuel Bubbling...........................	140	psig
f.	LOX Dome Purge Bypass...................	250	psig
g.	Auxiliary Inboard LOX Dome Purge.........	650	psig

11. ENGINE DATA:

TEST SA-19

ENGINE	ENGINE NUMBER	ENGINE ORIFICES (INCHES DIAMETER) GG LOX	GG FUEL	TURBINE SPINNER	MFV	MAIN LOX	MAIN FUEL	MLV	LOX TO H.E.	ENGINE ACCUMULATED TIME (Seconds)
1	H-5023	0.316	0.600	0.870	0.073	None	0.650	0.116	0.102 (3)	592.2
2	H-5012	0.314	0.576	0.870	0.073	None	2.834	0.116	0.102 (3)	380.1
3	H-5025	0.323	0.600	0.870	0.073	None	2.908	0.116	0.102 (3)	511.9
4	H-5026	0.325	0.600	0.870	0.073	None	2.700	0.116	0.102 (3)	395.7
5	H-2020	0.339	0.652	0.870	0.073	None	2.672	0.116	0.102 (3)	483.8
6	H-2022	0.325	0.600	0.870	0.073	None	2.740	0.116	0.102 (3)	557.6
7	H-2023	0.317	0.600	0.870	0.073	None	2.821	0.116	0.102 (3)	425.2
8	H-2024	0.318	0.600	0.870	0.073	None	3.067	0.116	0.102 (3)	467.0

* Time through test SA-19, measured from Pc reaches 90% to Pc decays to 90%.

APPENDIX F

METEOROLOGICAL DATA

METEOROLOGICAL DATA
TEST SA-19
MARCH 24, 1964

LOCATION	BLOCKHOUSE			TOP STATIC TEST TOWER	
TIME OF DAY	TEMP. (°F)	BAROMETRIC PRESS. (in. Hg)	RELATIVE HUMIDITY (%)	WIND VELOCITY (mph)	WIND DIRECTION (degrees)*
7:00 a.m.	55	**	93	10	135
7:30 a.m.	57	**	82	10	135
8:00 a.m.	58	**	77	7	130
8:30 a.m.	59	**	73	7	125
9:00 a.m.	61	**	70	6	125
9:30 a.m.	63	**	72	8	195
10:00 a.m.	65	**	72	9	185
10:30 a.m.	66	**	70	10	195
11:00 a.m.	67	**	68	9	195
11:30 a.m.	68	**	64	11	160
12:00 m.	69	**	60	8	210
12:30 p.m.	70	**	58	8	210
1:00 p.m.	71	29.453	54	7	180
1:30 p.m.	72	**	53	10	185
2:00 p.m.	73	**	51	7	185

* Wind direction is given in degrees starting north proceeding clockwise.
** Measurement not recorded

APPENDIX G

CRITICAL COMPONENTS TIME/CYCLE HISTORY OF STAGE S-I-9 WHILE AT TEST LABORATORY

CRITICAL COMPONENTS TIME/CYCLE HISTORY OF STAGE S-I-9 WHILE AT TEST LABORATORY

ITEM	SERIAL NUMBER	TIME OR CYCLES
Engine 1	H-5023	181.32 Seconds
Engine 2	H-5012	181.32 Seconds
Engine 3	H-5025	181.32 Seconds
Engine 4	H-5026	181.32 Seconds
Engine 5	H-2020	177.43 Seconds
Engine 6	H-2022	177.43 Seconds
Engine 7	H-2023	177.43 Seconds
Engine 8	H-2024	177.43 Seconds
Auxiliary Hydraulic Pump Engine 1	MX 85021	68.1 Minutes
Auxiliary Hydraulic Pump Engine 2	MX 72956	68.9 Minutes
Auxiliary Hydraulic Pump Engine 3	MX 85016	63.7 Minutes
Auxiliary Hydraulic Pump Engine 4	MX 85011	59.0 Minutes
Auxiliary Hydraulic Pump Motor Engine 1	1297661	68.1 Minutes
Auxiliary Hydraulic Pump Motor Engine 2	1276739	68.9 Minutes
Auxiliary Hydraulic Pump Motor Engine 3	1297834	63.7 Minutes
Auxiliary Hydraulic Pump Motor Engine 4	1297656	59.0 Minutes
Accumulator Reservoir Engine 1	112	68.1 Minutes
Accumulator Reservoir Engine 2	86	68.9 Minutes
Accumulator Reservoir Engine 3	109	63.7 Minutes
Accumulator Reservoir Engine 4	110	59.0 Minutes
Turbine Exhaust Duct Engine 1	8255443	181.32 Seconds

ITEM	SERIAL NUMBER	TIME OR CYCLES
Turbine Exhaust Duct Engine 2	8255444	181.32 Seconds
Turbine Exhaust Duct Engine 3	8255448	181.32 Seconds
Turbine Exhaust Duct Engine 4	8255446	181.32 Seconds
Turbine Exhaust Duct Engine 5	83B5501	177.43 Seconds
Turbine Exhaust Duct Engine 6	83B5505	177.43 Seconds
Turbine Exhaust Duct Engine 7	83B5503	177.43 Seconds
Turbine Exhaust Duct Engine 8	83B5500	177.43 Seconds
Turbine Assembly Engine 1	RN044R	181.32 Seconds
Turbine Assembly Engine 2	RN005R	181.32 Seconds
Turbine Assembly Engine 3	RN045R	181.32 Seconds
Turbine Assembly Engine 4	RN046R	181.32 Seconds
Turbine Assembly Engine 5	RN025R	177.43 Seconds
Turbine Assembly Engine 6	RN040R	177.43 Seconds
Turbine Assembly Engine 7	RN036R	177.43 Seconds
Turbine Assembly Engine 8	RN037R	177.43 Seconds
Turbopump Engine 1	RN043R	181.32 Seconds
Turbopump Engine 2	RN004R	181.32 Seconds
Turbopump Engine 3	RN042R	181.32 Seconds
Turbopump Engine 4	RN044R	181.32 Seconds
Turbopump Engine 5	RN025R	177.43 Seconds
Turbopump Engine 6	RN034R	177.43 Seconds
Turbopump Engine 7	RN036R	177.43 Seconds
Turbopump Engine 8	RN037R	177.43 Seconds

ITEM	SERIAL NUMBER	TIME OR CYCLES
Ignition Monitor Valve Engine 1	RN025T	5 Cycles
Ignition Monitor Valve Engine 2	2416438	15 Cycles
Ignition Monitor Valve Engine 3	RN029T	5 Cycles
Ignition Monitor Valve Engine 4	RN026T	5 Cycles
Ignition Monitor Valve Engine 5	RN014T	5 Cycles
Ignition Monitor Valve Engine 6	RN035T	6 Cycles
Ignition Monitor Valve Engine 7	RN021T	6 Cycles
Ignition Monitor Valve Engine 8	RN018T	6 Cycles
Igniter Fuel Valve Engine 1	R035V	2 Cycles
Igniter Fuel Valve Engine 2	R015V	3 Cycles
Igniter Fuel Valve Engine 3	R019V	2 Cycles
Igniter Fuel Valve Engine 4	R037V	3 Cycles
Igniter Fuel Valve Engine 5	R016V	2 Cycles
Igniter Fuel Valve Engine 6	R020V	2 Cycles
Igniter Fuel Valve Engine 7	R008V	2 Cycles
Igniter Fuel Valve Engine 8	R036V	2 Cycles
Thrust OK Pressure Switch Engine 1	150	14 Cycles
Thrust OK Pressure Switch Engine 2	149	14 Cycles
Thrust OK Pressure Switch Engine 3	138	17 Cycles
Thrust OK Pressure Switch Engine 4	143	15 Cycles
Thrust OK Pressure Switch Engine 5	137	14 Cycles
Thrust OK Pressure Switch Engine 6	146	15 Cycles
Thrust OK Pressure Switch Engine 7	147	11 Cycles

ITEM	SERIAL NUMBER	TIME OR CYCLES
Thrust OK Pressure Switch Engine 8	148	15 Cycles
Calorimeter Purge Control Valve	409	18 Cycles
LOX Fill and Drain Valve Tank O-3	135	47 Cycles
Fuel Fill and Drain Valve Tank F-1	244	93 Cycles
Prevalve Control Valve Engine 1	619	125 Cycles
Prevalve Control Valve Engine 2	628	119 Cycles
Prevalve Control Valve Engine 3	612	114 Cycles
Prevalve Control Valve Engine 4	416	118 Cycles
Prevalve Control Valve Engine 5	412	120 Cycles
Prevalve Control Valve Engine 6	623	118 Cycles
Prevalve Control Valve Engine 7	625	117 Cycles
Prevalve Control Valve Engine 8	622	118 Cycles
Fuel Prevalve Engine 1	238	121 Cycles
Fuel Prevalve Engine 2	241	117 Cycles
Fuel Prevalve Engine 3	221	114 Cycles
Fuel Prevalve Engine 4	223	117 Cycles
Fuel Prevalve Engine 5	229	118 Cycles
Fuel Prevalve Engine 6	231	117 Cycles
Fuel Prevalve Engine 7	226	115 Cycles
Fuel Prevalve Engine 8	219	115 Cycles
LOX Prevalve Engine 1	156	125 Cycles
LOX Prevalve Engine 2	144	119 Cycles
LOX Prevalve Engine 3	130	114 Cycles

ITEM	SERIAL NUMBER	TIME OR CYCLES
LOX Prevalve Engine 4	145	118 Cycles
LOX Prevalve Engine 5	133	120 Cycles
LOX Prevalve Engine 6	137	118 Cycles
LOX Prevalve Engine 7	150	117 Cycles
LOX Prevalve Engine 8	151	118 Cycles
Control Sphere Fill and Vent Valve	146	21 Cycles
Control Sphere High Pressure Oil Pressure Switch	25313	22 Cycles
Control 750 Pressure OK Pressure Switch	15780	6 Cycles
Fuel Vent Valve 1	214	209 Cycles
Fuel Vent Valve 2	213	209 Cycles
Fuel Pressurizing Valve 1	256	107 Cycles
Fuel Pressurizing Valve 2	263	108 Cycles
Fuel Pressurizing Valve 3	265	101 Cycles
Fuel Tank Pressurized Pressure Switch	138	48 Cycles
Fuel Spheres Pressure OK Pressure Switch	25326	32 Cycles
Helium Sphere Pressure OK Pressure Switch	25323	53 Cycles
LOX Tank Vent Valve 1	C0007	140 Cycles
LOX Tank Vent Valve 2	C0009	215 Cycles
LOX Tank 7 Inch Vent Valve	C050	140 Cycles

ITEM	SERIAL NUMBER	TIME OR CYCLES
Control Valve LOX Vent 1 and 7 Inch Vent	592	140 Cycles
Control Valve LOX Vent 2	613	152 Cycles
LOX Emergency Vent Pressure Switch	25255	14 Cycles
LOX Tank Pressurized Pressure Switch	25256	26 Cycles
LOX/SOX High Pressure Valve 1	249	52 Cycles
LOX/SOX High Pressure Valve 2	250	43 Cycles
LOX/SOX Purge Valve 1	261	30 Cycles
LOX/SOX Purge Valve 2	260	11 Cycles
LOX/SOX Purge Valve 3	248	12 Cycles
LOX/SOX Purge Valve 4	257	11 Cycles
LOX/SOX Purge Valve 5	259	11 Cycles
LOX/SOX Purge Valve 6	262	11 Cycles
LOX/SOX Purge Valve 7	253	11 Cycles
Inverter, 450 Volt	SAM-023	13,176.4 Minutes
Measuring Voltage Supply	SA-116	13,312.3 Minutes
Telemeter F-1	110	2084.4 Minutes
Telemeter F-2	111	1963.7 Minutes
Telemeter F-3	107	1957.8 Minutes
Telemeter S-1	123	1799.1 Minutes
Telemeter S-2	124	1720.1 Minutes
Measuring Selector Power Supply		3100.5 Minutes
D.D.A.S. Assembly P-2	13A485	12,973.1 Minutes

APPENDIX H

UNSATISFACTORY CONDITION REPORTS LIST

DATE	UCR NO. (TEST)	INSPECTION REPORT NO.	PART NAME	PART NO.	SERIAL NO.	DESCRIPTION OF DIFFICULTY	ACTION TAKEN
4/3/64	10666	KF-923	Tube Assembly	10M10003	N/A	Control pressure tubing assembly broken at "B"-nut connection to engine 8 fuel prevalve. The prevalve had been leak checked during the control system leak check after test SA-19 and prior to discovery of the defect and no leakage was found.	Made all test personnel aware of the seriousness of a failure like this during static firing or launch and cautioned everybody to be extremely careful and observant while performing their tasks.
2/19/64	90027	N/A	Cable 10W3	40M30430	N/A	Engine No. 3 conax squib No. 1 did not indicate a signal was received to initiate firing of the squib. Relay K13 of the 9A1 distributor was not being energized.	Distributors 12A1 and 9A1 was modified by manufacturing engineers wiring shop (R-ME-DAE) to configuration of EO#10-40M30439 to utilize a spare conductor in cable 10W3.
2/20/64	90028	N/A	Heater Monitor Panel	40M01666	N/A	Ammeter measuring current for LOX P switch heater and fuel P switch heater was exceeding maximum full scale value during performance of procedure 1-CH S1-427 engine component heaters checks.	The heater current was measured with a clamp-on ammeter and found to be 750 milliamps. The maximum value on the meter-scale is 500 milliamps. The specifications for 10M01386 (LOX P switch) and 10M01396 (Fuel P switch) specified 80 watts maximum which would require approximately a full scale reading.
2/ /64	90029	N/A	Programmer	21883	N/A	Would not scan the cells and read out proper voltage.	Cleaned relay contacts.
3/ /64	90030	N/A	Beckman Model #3255-7	21883	N/A	Would not scan the cell and read out proper voltage.	Replaced relay.
3/9/64	90031	N/A	Ampere Hour Meter		N/A	During checks of the battery, it was not possible to switch the batteries from the charger to the load bank.	Replaced Ampere-hour meter assembly.
3/9/64	90032	N/A	Cable 4W3	40M30443	N/A	During performance of pre-test ordnance checks, conax squib #1 on Engine #4 did not fire.	Voltage checks at the time revealed no voltage present at the conax squib. Troubleshooting the next day revealed voltage was present at the conax squib. A new conax was installed and fired. The original conax was again installed and this time it fired. A failure was again experienced during performance of Simulated Flight Test 7-CH S1-610. Subsequent troubleshooting revealed open in cable 4W3/P3-B. The cable was replaced, by R-ME-DAE, with a like part from a spare engine.

UNSATISFACTORY CONDITION REPORTS

DATE	UCR NO. (TEST)	INSPECTION REPORT NO.	PART NAME	PART NO.	SERIAL NO.	DESCRIPTION OF DIFFICULTY	ACTION TAKEN
3/3/64	10643		Union, Straight Bulkhead	MC164C4W	N/A	A fuel leak was discovered at engine position No. 7. At the connection between the fuel high pressure bleed line, P/N 20M51035, and the bulkhead union, P/N MC164C4W.	The bulkhead union, P/N MC164C4W, was replaced and another leak check performed. No leakage was observed.
3/3/64	10644	KF-916	Valve, Ball Rotor Shutoff, LOX	20M30042	N/A	Position indicator failed to indicate closed when valve was closed upon completion of LOX drain.	Valve cycled open then closed 3 times. LOX tanks were then pressurized to confirm the valve closed.
2/27/64	10645	N/A	MV-130 T Solenoid Valve	212783-1	N/A	The valve is normally closed with no power on the solenoid. However the microswitch on the valve indicated that it was in the open position with no power applied to the solenoid.	Valve was replaced by a like item.
3/9/64	10646	KK-388	Valve Ball Rotor Shutoff, LOX	20M30042	N/A	Upon closing of prevalve with LOX on board, the closed indication would come on then off before returning to closed indication. Position No. 5	Prevalve replaced with like item S/N 117.
3/13/64	10647	N/A	7 Inch LOX Vent Valve	20M30122	N/A	CLOSED indication failed upon valve closure during countdown for static firing SA-18. Valve did close as indicated by LOX tank pressure rise.	None
3/13/64	10648	N/A	Resistance Bulb	50M10412	N/A	Transducer opened 20 seconds after ignition.	Replaced transducer after static test.
3/13/64	10649	N/A	Accelerometer	D233M1	N/A	Lead broken at transducer sometime after final peck check-about 3:00 p.m.	Replaced transducer after static test.
3/6/64	10650	N/A	Pressure Transducer	2004202601	N/A	Transducers set-up for propellant loading test; recorder readings were erratic.	Transducer replaced by Wiancko for short duration only.
3/6/64	10651	N/A	Pressure Transducer	2004202601	N/A	Transducers set-up for propellant loading test; recorder readings were erratic.	Transducer replaced by Wiancko for short duration test only.
3/6/64	10652	N/A	Pressure Transducer	2004202601	N/A	Transducers set-up for propellant loading test; recorder readings were erratic.	Transducer replaced with Wiancko for short duration test.
3/6/64	10653	N/A	Pressure Transducer	2004202601	N/A	Transducers set-up for propellant loading test. Recorder reading was erratic.	Transducer replaced with Wiancko for short duration test.
3/6/64	10654	N/A	Pressure Transducer	2004202601	N/A	Transducers set-up for propellant loading test. Recorder reading was erratic.	Transducer replaced with Wiancko for short duration test.

DATE	UCR NO. (TEST)	INSPECTION REPORT NO.	PART NAME	PART NO.	SERIAL NO.	DESCRIPTION OF DIFFICULTY	ACTION TAKEN
3/6/64	10655	N/A	Pressure Transducer	2004202601	N/A	Transducers set-up for propellant loading test. Recorder readings were erratic.	Transducer replaced by Wiancko for short duration only.
3/6/64	10656	N/A	Pressure Transducer	2004202601	N/A	Transducers set-up for propellant loading test. Recorder readings were erratic.	Transducers replaced by Wiancko for short duration only.
3/6/64	10657	N/A	Pressure Transducer	2004202601	N/A	Transducers set-up for propellant loading test. Recorder readings were erratic.	Transducers replaced by Wiancko for short duration only.
3/10/64	10658	N/A	Pressure Transducer	50M10257	N/A	During calibration, transducer stuck at 80% of calibration value.	Transducer replaced by Wiancko for short duration test only.
3/16/64	10659	N/A	Injector Plate Assembly	205181	H-2022	A piece of wire, 0.032 inch in diameter, was protruding from one of the thrust chamber injector LOX orifices at engine 6. The location of this LOX orifice is shown on the attached detail.	An attempt was made to remove the wire from the LOX orifice. The wire broke off, thus leaving a piece in the orifice. Due to negligible effect on engine performance, no further action was taken.
3/27/64	10660	KK-397	Valve Assembly	20M30046	N/A	Excessive reverse flow through check valve. Flow exceeds 2500 scims at 10 psig. Maximum allowable - 50 scims at 10 to 1500 psig. Engine position number 8.	Removed check valve serial No. RN 086 V and installed check valve serial No. R 1587.
3/24/64	10661	N/A	Transducer, High Pressure, Hydraulic System	20M85079	109	Throughout test SA-19, erratic fluctuations were indicated by the hydraulic supply pressure trace (measurement D29) for engine position No. 3.	None
3/24/64	10662	N/A	Gauge, Pressure	50M10039	N/A	During test SA-19 ignition to mainstage transition, a zero shift was indicated by the yaw actuator differential pressure transducer (measurement D30) at engine position No. 2.	None
3/14/64	10663	KF-917	Nut-Drilled Hex, Boss	RD114-1003-1004	N/A	The Nut (P/N RD114-1003-1004), which locks the gas generator LOX injector purge fitting (P/N 307410) to the gas generator at engine position No. 5 (S/N H-2020), was found to be rusty.	None

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